Lesson 100 - Restructuring The Way We Produce Our Foods - Part II

- 1. Introduction
- 2. Water, Water Everywhere?
- 3. Ecology And Climate
- 4. Politics Of Food Production
- Article #1: Tropical Rain Forests: Earth's Green Belt

1. Introduction

"The Sky is Falling!" ... or is it?

Once upon a time there lived a storybook character named Chicken Little, who said the sky was falling—this is about as cheerful as most of the news we're subjected to nowadays, and if it appeared as tomorrow's newspaper headlines, it probably wouldn't even raise many eyebrows in comparison. (It'd make a nice *National Enquirer* headline!) In gathering material for this lesson I was soon saturated with one piece of "bad news" after another—certainly no shortage of negative environmental factors to be found, and I began to wonder how I could ever present both the good and the bad sides of the story without sounding like a "doomsday prophet"! Yet, reality *is* made up of both sides. So, before going any further with our discussion on ecology, let me clarify what my intentions *are* in opening our Pandora's box of world problems. I'd much rather be the bearer of good news, so my purpose in this lesson is a dual one: to admit our mistakes honestly *and still* count our blessings, the *good news* being that we're finally discovering the limited scope and potential of *self* consciousness, and evolving to an awareness of the broader scope and potential of our *collective* (or universal) consciousness, i.e., *what we do to others, we do to ourselves*. We are creating our *mutual destiny* daily, and what we create also depends upon the strength of our *will to live*. Since negative attitudes are self-fulfilling and self-defeating, please keep your chin up when reading this lesson. Its purpose is also not to attempt to *predict* future events, climates, or cataclysms, but to evaluate our world as it *is* and *could be*. The question is not so much whether the sky is falling, it is whether *we* will let *ourselves* fall. If we give up hope, and throw in our cards early in the game, we give up our destiny as well. My purpose in writing this lesson is to present the rose in all its beauty and to smell its sweet fragrance, but to *watch out* for the thorns. I hope the lesson will inspire you and challenge you to discover, and create, a beautiful future for all of us.

When we see the reality of what is happening to all of us, the total picture can't help but stir up many mixed emotions. Few of us enjoy speculating on potential destruction/devastation of our planet. We want to be positive and cheerful, and would almost rather not hear the bad news at all, but there's also a difference between the bad news given by the broadcaster with little emotion and the bad news that comes with suggestions as to how changes can be made and how we can help ourselves—the latter news is motivated by a desire to help humanity. We can listen and learn from Hamaker, for example, and should get over our resistance to confronting reality. Not only does it keep us ignorant, but avoidance of the truth does *nothing* to change the situation. When we have a flat tire, we know that we'll have to fix it—a temper tantrum or flood of tears might fit the mood of the occasion, but they won't *fix* the tire. It's the same with world problems. When we're faced with the complexity and seriousness of our *total world reality*, the tendency is to become overwhelmed at first. This is only natural. After grudgingly *adding up* all the environmental factors involved, in our minds, we can't see our earth's state of health without an overwhelming sense of urgency that *so much* needs to be done—like looking at stacks of dirty dishes the

morning after a party, only we have a lot more to clean up on earth. Where to begin? What can "just one" person do? Well, it becomes apparent what "just one" person can do if we look at the world around us—we're already doing it *now*, every day, all together at every moment, and the continual combined impact of *all* human action/interaction at once on the globe is no small matter. What "just one" person can do (and does) amounts to a lot since we're all doing it at the same time, and it adds up even more quickly when *everyone* is doing it *constantly*.

Our collective energy is just as capable of *healing* as it is of *destroying*. Once we *imagine* what we can do with this incredible healing power if our collective energy is used in a positive way, we have but to realize our fullest potential by *living* it. Unity and harmony will bring a new dimension of growth to our collective human energy. If we could but see the *heights* our spirits will reach when we build together, we would shun the *depths* our spirits sank to with pettiness, violence, and destruction. We would outgrow these primitive rituals—we have no use for them in our quest for a better world.

We must pass through the "crisis point", and bypass the *emotional traps that keep us from changing what we dislike, by misdirecting and draining our energy*: anger, blame (of self and others), revenge, guilt, self-pity, fear, confusion, delusion, anxiety, wishful thinking, depression, apathy, and inertia. All of these traps can become *obsessive*; they immobilize us; and, in fact, we often confuse the emotions themselves with actual *action*. Strong emotions drain us physically as well as mentally, giving the impression that we've expended a lot of energy (we have, but it was misguided and wasted). Emotions do not *act—we* act—our feelings are incapable of *acting* on their own (aside from their mental effects). We often resort to them because they offer immediate "satisfaction", an outlet or channel for our feelings—they become harmful when used in excess or to harm others. What is needed is *action*, after the reaction, not more expenditure of energy in the reaction itself. All time spent wondering "what if?" and "why?" is better used doing something or changing something, or even watching your garden grow or simply *smiling* at someone.

If we try to submerge negative images into our subconscious minds, we'll never be able to bury them deep enough as long as they exist. Just as with the Pandora's box, as long as the problems remain unsolved, keeping the lid shut won't make them go away. Ostriches have devised an ingenious way of dealing with "scary things they'd rather not see"—if the enemy approaches, they merely bury their heads in the ground—unfortunately, what we don't see or don't know can also hurt us. If we avoid looking at our problems, because we don't want to *see* the "enemy", how will we *know* our enemy? We need to know the enemy in order to keep one step ahead of its *grasp*. Refusing to look at the world as it really is, is like our avoiding mirrors when we have a pimple—we'd rather wait until it goes away. Is that what we're planning on doing with our world problems?

Once upon a time there was a happy ending for every story, and like breathless children listening to a fairy tale, we anticipate the book's final moment of magic and salvation *in just the nick of time*. Are we lured by the thrill of danger that comes with our defiance of Nature, and thereby *daring* our life source to *react* to our defiance? Well be sadly disappointed when we discover that the knight isn't coming on his horse to carry us off to safety *at the last minute*, and it's time we realized that the horse has been waiting for *us* all along in an empty pasture, for it is we ourselves that are meant to be the heroes in this story. We've been writing this one all together, all our lives, and it's about time we paused for a moment to read the chapter on psychic numbing. We get "tired" of bad news, try to harden ourselves, desensitize ourselves so as to feel less pain, to feel less vulnerable. This is understandable considering the harsh realities we face at times, but it is also a type of psychic defense mechanism we've adopted to deal with our environment—we try to "adjust" our reality to our own particular tolerance level. Whereas we find the ostrich's defense mechanism ludicrous, our amusement should fade when we realize we're doing *exactly* the same thing with our numbing mechanisms.

Sensitivity is our best defense against numbing apathy— the less we close our eyes to truth, the more we see. Sensitivity can also help us deal with *in*sensitivity around us—we can imagine how little an insensitive person feels because we know how *much* we feel, as sensitive persons. People of the strongest character, courage, honor, clarity of perception, vision, and greatest physical strength, are often

the most *sensitive* persons around. The more sensitive you are, the more you experience in life.

A bird can't fly until it jumps out of the nest. As we busy ourselves in our nests, rearranging furniture and curling up in front of the fire for a cozy nap, we sometimes hear the distant rumblings of change on the horizon. The thought of jumping from our nest disturbs us, but if we want to feel the freedom of spirit possible in our lives, we'll have to take a chance *someday*. The light of a new dawn is breaking on the horizon. It's a good day for learning to fly.

2. Water, Water Everywhere?

It can easily cost 500 to 2,000 gallons of water to produce a typical American meal. According to Rep. Tony Coelho (D., Calif.), agriculture accounts for 80% of all water consumption in America. It takes the use of 408 gallons of water to get one serving of chicken to a dinner able, 12 gallons for one 8-ounce baked potato, 18 gallons for one serving of green beans and 6 gallons for a salad. A dinner roll takes 26 gallons of water, plus 100 gallons for the pat of butter on it. That adds up to 570 gallons for one "conventional" meal. *A steak alone costs 2,607 gallons of water.* On the average, it takes about 1,630,000 gallons of water to feed *one* American for a year. (*Parade Magazine*, Sunday newspaper supplement, 3/25/84.)

It must be obvious that water is, indeed, a very precious resource and one that is all too often taken for granted.

Soil water has three forms: hydroscopic, gravitational and capillary. Hydroscopic water is chemically-bound in the soil constituents and unavailable to plants. Gravitational water is water that normally drains out of the pore spaces of the soil after a rain, and if drainage is poor, it is this water that causes the soil to be soggy and unproductive. Excessive drainage, on the other hand, makes capillary water run short sooner, and plants suffer from drought. Plants depend on capillary water for their supply of moisture, so the ability of soil to hold water against the pull of gravity is important. Organic matter and good soil structure add to this supply of water in soils. Plants can't extract the last drop of capillary water from soil since the attraction of soil materials for it is greater than the pull exerted by the plant roots. The point at which these two forces are equal is called the willing coefficient of a soil, that is, the percentage of water in a soil when water loss from transpiration exceeds renewal of the water by capillary means. Medium-textured loams and silt loams (because of their faster rate of movement of moisture from lower depths of the root zone, and the fact that they can bring up moisture from greater depths than either sands or clays) provide the best conditions of available (but not excessive) soil moisture for best plant growth. (*Rodale Press*)

The following excerpts on water come from *The Survival of Civilization*, page 22:

> "The microorganisms in a rich soil build the soil to take in rainwater and hold it in storage. The proper proportion of water in protoplasm is 90%. It is important that protoplasm be maintained as a dilute solution. Water evaporates from the leaves of the plant, concentrating the protoplasm solution. It is characteristic of water solutions that the water of the more dilute solution will pass through a membrane into a more concentrated solution. This force of osmosis is very powerful. It is the force that moves the water to the top of a sequoia. Water is, of course, necessary to all cells in order for them to function. Cells have a way of opening up and engulfing the very large molecules of protoplasm. Since the cells are alive and expend energy, they probably pass the I molecules or its components from one cell to

another until it reaches the part of the plant where it is needed. If dry weather depletes the water held by the soil and the microorganisms to the concentration of the water in the leaf cells, all protoplasm feeding stops and growth is arrested.

"Irrigation is not the answer to water shortage problems. If all farmers irrigated, the underground water supplies would soon be depleted (as they are in the process of becoming now). The answer is to keep feeding microorganisms until the aerated zone is 18 to 24 inches deep and capable of holding all the rain that falls until the excess can seep into the subsoil and reach the underground aquifer, instead of running off the surface and taking the soil with it. It will take a decade or two for roots and earthworms to deepen the topsoil significantly below plow depth.

"Nitrogen from the air is the ultimate source of most of the nitrogen in the protein compounds of the microorganism protoplasm, the solid matter of which is about 2/3 protein. It is not, however, the principal source of crop-growth nitrogen. The same is true of carbon, which is the dominant element in all organic matter. The leaves take in CO2 and give off oxygen, retaining the carbon for the necessary carbohydrate construction and for energy requirements. When the plant dies, it goes into the soil or on the soil where it is used as a part of the food supply of various soil organisms. Eventually it is all carried into the soil, principally by earthworms as they combine leaf mold with minerals ground in their gizzards to produce microorganisms. Their castings are almost all microorganisms, and a source of protoplasm not overlooked by the hair roots of plants. Since the rye plant has been estimated to have a root system seven miles long, it is apparent that plants can do a lot of searching for protoplasm. The root tips grow a lot faster than microorganisms can move, so the microorganisms are easy prey to roots. When in intimate proximity to the cell, the flow of protoplasm begins.

"The root cannot take in the cell membrane of the organism. The membranes are held against the root by the pressure of other cells forced against the root by the diffusion pressure between the microorganism cells and the root cells. Soon the older root cells are all plugged with microorganism cell membranes, which subsequently turn the brown color of all mature roots. The root functions simply as a pipe, while the rapidly-growing white root tips continue to devour cell protoplasm.

"If the protoplasm of the root cells gets too dry, then the protoplasm intake must stop because osmosis requires that the more concentrated solution in the microorganisms must flow toward a more dilute solution in the plant cells. For this reason the root tips (which can take in soil water) constantly remove water from the zone where they are feeding, and the water is moved upward toward the leaves, keeping the cells saturated and evaporating the excess.

"The intestinal tract of all animals works essentially the same way, except that the microorganisms and their food supply are inside Intestines and the protoplasm compounds feed into the intestinal wall where they are picked up by a blood vessel system for sorting out in the liver. Excess water passes readily through the system and is ultimately evaporated from the sweat glands or extracted by the kidneys and excreted in the urine.

"Nature has used just one basic design for all the living organisms with variations as required by each type of organism."

As we said in our section on chemical fertilizers and pesticides, plant and animal digestive systems will

readily pass water into the plant or animal, so if toxic compounds are in solution in the water, they too will pass readily into the plant/animal.

> "We see, then, that the rate of production of microorganisms will be high if: the soil contains a large surface area of available elements; a large supply of plant residue for carbon and a little nitrogen; plus the nitrogen that many organisms can take from the air as the air breathes in and out of the soil with temperature changes; water and the other necessary factors from the air."

We have seen that the key to achieving crop growth depends on a *delicate balance* between minerals available/absorbed, water, climate, and so on. It must be obvious by now that we cannot just "dump chemical fertilizers onto the soil at random and pour lots of water onto it," and expect to match nature's achievements! Irrigation is not the same as natural rainfall (i.e., rain as it *should* be, not acid rain) in the first place; in the second place, most water is full of chemicals by the time it flows through our taps.

2.1 We Don't Miss the Water Till the Well Runs Dry. . .

We will also talk about drought later in this section and again in our section on climate later on in this lesson. Barry Slogrove (ecologist) says the Southern hemisphere is suffering droughts like never before because of the transfer of cloud cover across the equator to the north—this is visible on satellite photographs. The results are felt in Australia, which has the worst drought in human history, and also in Africa, which has also suffered severe drought. The rain *volume* may be the same, but the precipitation patterns are different, which means that less moisture actually gets into the soil. (Slogrove also maintains the view that an Ice Age is on the way.)

In 1984, much of Texas suffered under *heavy* drought and in the Austin area, water use during the spring of 1984 far exceeded previous spring consumption (and exceeded peak use in the summer of 1983). To encourage public awareness of water use, the newspaper published water consumption figures daily. *Voluntary* water conservation was at first in effect (each day, households whose last number of their street address is the daily given number may water their lawns on that day—this amounts to watering every *fifth* day only). *Mandatory* water conservation began after three consecutive days at 150 million gallons usage. In Corpus Christi, Texas, mandatory water rationing to limit lawn watering and car washing began July 1 in this drought-plagued city. The new ordinance, carrying a fine of up to $200 for violators, was to continue indefinitely until the Nueces River watershed was replenished. (Alice, Texas, also instituted mandatory rationing in May.) Corpus Christi had called for voluntary water conservation in May, but officials said that residents didn't heed the request.

The following tips on conserving our precious water supplies were offered by the Austin newspaper, suggestions which can be put into practice by *all* Americans to save water and to increase consciousness so that water won't be taken for granted and wasted so often.

2.2 The Lawn

Water deeply and infrequently to get a good root structure, which can't be achieved by frequent shallow waterings. Water long enough for water to seep down to the roots. Check soil before watering; if it springs back when you step on the grass, it doesn't need water yet. Water during cool parts of the day, and don't water while the wind blows, because wind increases evaporation. Oscillating sprinklers are among the least efficient because they spray many thin streams of water high in the air. Use sprinklers that make big drops and keep the water close to the ground. Among the better sprinklers are the smaller versions of sprinklers used by golf courses or park operators, which rotate, sending pulses of water in a circular pattern (Rainbird makes these). Try a drip hose in odd-shaped areas. The least evaporation occurs when water is applied directly to the ground with a perforated hose or other drip irrigation method. Don't water the gutter—arrange hoses and sprinklers so the water doesn't run onto concrete. Even in instances where it appears the water is running off a sidewalk onto a lawn, a large part of the

water evaporates. If you have an automatic sprinkler system, set the timer to operate between 4 and 6 a.m., when demand on city systems is at its lowest. Don't scalp your lawn. Set your mower to cut no lower than 1 1/2 inches; better still, 2 inches. Taller grass holds moisture better. A rule of thumb is not to cut more than 1/3 of the height of the grass. If planting new sod or grass, prepare the soil with compost so water won't run off (the same idea works in gardens).

2.3 Landscaping

Use native trees and shrubs that are hardiest in your area. Put a layer of mulch around trees and plants. Not only does this conserve moisture and keep the soil around plants cooler, but it also adds nutrients if leaves are used, have *some* weeds for insects and balance (polyculture), but not so many that they are taking too much water away from vegetables.

2.4 Other watering

Don't use a hose as a broom, to "sweep" sidewalks and driveways, etc. Use a rake or broom. Use a bucket or a water can to water hanging plants—using a hose to go from basket to basket wastes more water than makes it to the plants. Cut down on car washing (if nothing else, for the sake of your paint job), and wash with a bucket of soapy water, using the hose only for rinsing. Put a nozzle on your hose.

For almost every outdoor job, you'll save water by using an attachment that lets you turn the water on and off at the end of the hose rather than at the faucet. (Don't forget to turn the faucet off when done.) Wash your car at a commercial car wash, since the high pressure equipment used by most will wash your car in less time and with less water than most people use at home.

2.5 Showers

Showers usually take no more than 1/2 as much water—sometimes less—than bath tubs. If you don't have a shower, you can still save several gallons of water simply by reducing the water in your tub baths by a few inches.

You can check your use by plugging the drain during a shower and comparing the water level with your normal bath. Also, bathing and shampooing at the same time cuts water use. Take a shorter shower. Most showers use 6 to 10 gallons of water per minute. If you install a low-flow shower head, that can be cut to 2 1/2 to 4 gallons per minute, and the new shower head will pay for itself within a few months.

2.6 Sinks

Use aerators in sinks. Aerators which are made to screw into most standard faucets will cut your water flow. Check faucets for leaks. *Even a small drip from a worn washer can waste more than 50 gallons of water a day—steady drips can waste hundreds*. When brushing your teeth, turn off the water until you rinse your mouth. (Children can be helped to develop this habit while still young.) When shaving, partially fill the sink to rinse your razor rather than rinsing with running water.

2.7 Toilets

Cut down on the number of flushes. An old-style toilet can use five or more gallons per flush! Frankly, that's a lot of water for a cupful of urine. Newer models use 3 1/2 gallons per flush or less. Cut the water level in the toilet. Fill two one-quart bottles with water and replace the caps. Put them in the tank, to reduce the water used per flush. Don't use bricks for this, because they will crumble and possibly damage the toilet. You can also reduce the level of water with the toilet's own equipment. Many have adjusting screws. In older toilets gently bend the float rod downward to reduce water level. Check for leaks. Add a few drops of food coloring to the tank. If the color appears in the bowl in a few minutes

(without flushing), you have a leak. Common sources of leaks are that the water level in the tank is too high or that the flapper ball and other parts are worn. Some plumbing supply stores and many stores that specialize in energy conservation sell inexpensive devices such as plastic water dams which will help reduce the amount of water used in each flush.

2.8 In the kitchen

Don't rinse the dishes with running water. If you have two sinks, fill one with hot rinse water. If you have only one sink, buy a small plastic tub for rinsing or gather washed dishes in a rack and rinse them when done with a spray device or by pouring water over them. Don't rinse vegetables with running water. Rinse them in a partially-filled sink or pan. Cooking with less water, such as by steaming, saves water and retains more vitamins in the food. (Of course, we might note here that *not* cooking retains even more vitamins!) Those who use garbage disposals are encouraged not to cut the disposal on (with water running all the while) for every little scrap, but to let them accumulate a bit—better still is to compost your scraps, of course. *Dishwashers use about 25 gallons of water per load*. Not only is this wasteful, but some people don't even fill the dishwasher with dishes each time. Any housewife who had to walk several miles for water and haul it back to the house would definitely think twice about using 25 gallons to wash dishes, that's for sure. Some new dishwashers have cycles that use as little as four gallons of water, but I still wouldn't promote the use of dishwashers. (Again, think of all the dishes and pots and pans you'll save washing on a raw food diet ...)

2.9 Laundry

Use the washing machine for full loads only. *Each load requires as much as 35 gallons of water — (some older machines actually use as much as 59 gallons)*. Try hauling that from a well. If you must wash only a few pieces, do it by hand. If you replace your machine, be sure to buy one with adjustable water levels. If you have a small family, consider a European-style, front-loading machine, which uses far less water than top loaders. If you live in a city, washing clothes, cars, etc., can be done on week-days since the heaviest demand on the water system tends to be on weekends. Check for leaks. In many older homes, the washer isn't located in the most convenient spot, which means that leaks can go undetected for weeks. Use cold water when possible.

2.10 Around the house

Turn down the hot water thermostat. High settings can waste water because you turn on more cold water at the faucet to mix with the hot. Check your buyer's guide or ask the store where you bought the appliance if you don't understand the range of settings on the dial. (If you don't know where the thermostat is, find out before an emergency.)

Evaluate your inside plant-watering schedule—check before watering—many plants die from overwatering as well as underwatering.

Insulate hot water pipes. The less time it takes for hot water to reach the tap, the more water you save. Check for system leaks. Turn off all faucets, then check your water meter. If it continues to run, you've got a leak.

Even if you don't live in an area that is prone to drought, it would be well to adopt as many water-saving habits as possible, because water is wasted needlessly, and is being used faster than nature can replace it in many places. As we said, children can be encouraged to develop a conscious attitude toward natural resources from the very beginning so that their conscientious habits become second nature to them—this is always easier than making the change later on in life. The next time you and your children brush your teeth, imagine that you live in a country where you must go to a distant well and carry your water home. How much water would you use in a day for all your needs? Could you imagine carrying that extra gallon or two that *each* of your family members lets run down the sink while brushing their teeth? It

would then become apparent how wasteful this really is. Nor could you afford to carry the extra few gallons that run down the drain each time you rinse your hands, a glass, or something to eat. These all add up—if you're fond of mental exercise, you may want to calculate your average daily household water use in gallons and multiply by 365 for a year's use. You'll be *amazed*.

2.11 Odds and Ends

Use dishwashing detergent sparingly. I've lived for months in areas where our dishwashing consisted of rinsing dishes in streams without even using soap *at all*, and the only available water was, of course, *cold* water. Since dishes were rinsed right after eating, there was certainly no real food decomposition yet, and we all remained as healthy as ever. Most people seem to think they need "*lots of suds*", but soap residue is unhealthy—and more suds also mean more water for rinsing. If dishes have been sitting a few days, soaking them first will help, and a pad that is "scratchy" but made not to harm dishes (such as those sold for Teflon surfaces) can be used to get them clean with very little soap.

If children want to play in the sprinkler in the hot summer, put it somewhere where the water can serve a triple purpose: water the grass, entertain the kids, *and* serve as their shower/bath that day. Many of us in today's society have become so "clean" conscious that we actually shower and bathe too often for our real needs, especially if we "scrub daily with soap". This destroys the skin's natural oils and protective bacteria—while many people believe that their "cleanliness will protect them from germs/illness", it is more the opposite that is true: they'll be hardier if they *don't* attempt to "sterilize" their bodies. For freshness sake, we may take a quick shower/rinse with a loofa sponge or washcloth. As children, my 2 sisters and I often took our baths all three at the same time—another way to save water.

If everyone were to develop even the minimal suggestions given above for conserving water, *billions* of gallons of water would be saved constantly with very little effort, i.e., just by cutting *wasted* water use alone. Imagine the following savings:

Gallons of Water Used	**Households that change**	**Gallons of water saved**
59-gal. washing machine to 35-gal. one	1,000 1,000,000	24,000 gal. each time 24,000,000 gal. each time
Not running a gal. of water down the drain while brushing teeth	50,000,000 people	50.000.000 gal. daily
Fixing a drip that wastes 100 gal. daily	1.000,000 people	100,000,000 gal. daily
Miscellaneous: 5 gal. of water saved daily by any change made	10,000,000 people	50,000,000 gal. daily

We can see how quickly this all adds up!

2.12 Soil Drainage

Many soils in the world have only enough water reaching the drainage layer to keep small streams flowing at intervals of 6 or 8 feet; the rest of the gravel layer has become infiltrated by clay, and the gravel has begun to rise toward the surface. We are in the process of losing the drainage layer on a worldwide scale. The destruction of the drainage layer has been further intensified because some farmers have installed toxic plastic drain pipes a few feet below the surface in order to short-cut the percolating

water and thereby further dry up the drainage layer.

Over 25 years ago, John Hamaker dug a pond in East Texas, and along 250 cut into the base of the hillside, there were only 2 or 3 sand channels where the water was still coming down the hill—all the rest had been sealed up by clay long ago. The water simply penetrated the 8" of sandy loam, to the dense clay beneath it and drifted downhill—an ideal set-up for sheet erosion if anyone tried to plow the land. Topsoil there eroded in heavy rains. There is a penalty for failure to maintain the drainage layer.

When lands begin to fall off in yield, they usually cease to have useful productivity in a few decades, and no amount of agricultural chemicals can bring that production back or keep it from dropping to a lower yield—at this point, the unused, fine rock material has stopped coming up from the subsoil because there isn't anymore. During the few decades when the soil collapses in yield, the fine material is used up and the major part of the surface area of rock is gone, i.e., the availability of elements has all but ended. This is why remineralization, as discussed later in this lesson, is needed—not random chemical "fertilizer" application, which is either unbalanced and/or lacks elements needed for proper growth of microorganisms, and thus, plant life itself.

All underground water eventually drains into a stream bed, or lake; it then comes up in springs at a lower elevation or runs directly into the ocean. The point is that the capacity of the subsoil drainage layer in any area has been geared to the annual rainfall and water penetration under natural conditions. When we alter the amount of water reaching and being maintained in the drainage layer, we are in trouble. If we decrease the amount of water by losing it to surface run-off, we will lose water and therefore sand and gravel from the drainage layer. This sand and gravel cannot be replaced. Arid soils have very little drainage layer left, simply because a drainage layer which isn't kept full of slowly-flowing water will clog up with fine, worn-out particles which will eventually displace the drainage sands and gravels and lift them to the topsoil. The sea salts carried in by infrequent rains accumulate in the soils for lack of sufficient water to establish drainage systems and thereby flush the salts back to the ocean. When dry lands are irrigated, they tend to become water-logged for lack of drainage. The salts dissolve and are left on the surface when surface moisture evaporates. The best use of arid soils is to put them back into grass, the way most of them were when the land was settled. With remineralization, more and better grass can be grown for animals. Many remineralized arid and semi-arid lands could also be afforested with valuable drought-resistant trees and shrubs (e.g. pistachio, jojoba). The water left in the underground reservoirs should be reserved for people and livestock. The refill rate of the reservoirs is much too slow to support irrigation, as shown by steadily-falling water tables in most exploited areas.

The mineral requirements to support the growth of soil organisms (hence plants) are a *natural* balance of the available (to the microorganisms) elements in the total mixture of the rocks on the top layers of the earth's crust, and the *natural* balance of the elements dissolved and suspended in sea water brought with the clouds. The mineral balance of salted soils must be restored by remineralization and by allowing large quantities of plant refuse to go back into the topsoil. The plant refuse would provide the carbon requirements of the microorganisms; the gases in the air and water complete their food requirements.

2.13 Drought

The Ethiopian drought is a forewarning of widespread regional water crises in the 1990s that could rival the energy crisis of the last decade, according to a study by the worldwatch Institute. Falling water tables and dry riverbeds indicate a widespread overuse of water resources, and if current trends continue, fresh water in many areas may become a constraint on economic activity and food production over the coming decades. In the United States, areas where excessive withdrawal of undergound water supplies threatens its future availability include the High Plains from Nebraska to Texas; the Colorado River basin, particularly the areas around Phoenix and Tucson; the Florida and Pacific coasts; and much of California. The report cites statistics from the U.S. Geological Survey estimating that the Ogallala Aquifer, used for irrigating one-fifth of U.S. cropland, is now half-depleted under 2,200,000 acres of Texas, New Mexico, and Kansas. Rising pumping costs and falling well yields associated with the

depletion of the Ogallala are causing farmers to take land out of irrigation. Still, most officials continue to take a "frontier approach" that looks to dams and other multibillion-dollar diversion projects as a solution, failing to see the unfortunate irony in the situation. While the government pays farmers to idle rain-fed cropland in an effort to avoid price-depressing surpluses, farmers are exhausting a unique, underground water reserve to grow these same crops. The government is encouraging waste of water from the Ogallala by giving farmers a depletion tax break based on the drop in the water level under their land. Instead, says Worldwatch, the government should be *taxing* that water use.

If we continue to ignore warning signs of future water shortages, and close our eyes to the waste and overuse of decreasing water supplies, we will pay dearly for our indifference. We need not imagine what our lives would be like without water—we need only look at the suffering people in Africa to see the stark reality of what extensive drought can do. Television brought the starving, emaciated bodies of drought victims into our living rooms in 1984, and it is a painful sight, but one that we must face up to. Thousands of people have been reduced to skeletons as the drought takes its toll.

In the African country of Mauritania, not only must they cope with the severe drought plaguing 6ther African countries as well, but they must also cope with the spreading Sahara desert—one government official says the parched and rainless country "could disappear from the map in 10 years, and become only sand." The Sahara is literally pushing southward; crews along a key highway passing through 690 miles of Mauritania wage a daily battle with the desert, trying to keep the road clear of wind-blown sands. Crops are gone after being withered by a drought that has affected some areas since 1969, and covered by the shifting dunes of the Sahara. With two-thirds of its land already swallowed up by the desert, Mauritania now produces only about 5% of the food it needs. Cereal production used to average 100,000 tons annually, but was estimated at 15,000 tons in 1984. The government is trying to, drill holes for water in the countryside to slow the rush to the towns. Vast herds of cattle (about 80%) have died, or have been driven into neighboring Senegal for grazing (Senegal agreed to allow up to 300,000 animals to graze there), but now Senegal is also suffering from a drought. Although it defies all laws of common sense to keep cattle in areas so dry that even human beings can scarcely find enough to eat (and many don't), these people are raising animals because they've done so as long as they can remember; they don't know any other lifestyle. (If we are tempted to pass judgment, let's look at our own Society—we've certainly made enough environmental errors ourselves, wasting resources for rapid gains that result in long-term losses. Being more educated, what excuse would justify our *own* lack of foresight?) Some Mauritanians have goats, and donkeys are, of course, a necessity for those who depend on them for work. The nomadic way of life has been a tradition for many people here. In the past, during the worst times of drought, nomads moved to farming areas, then returned to their old way of life when pasture became available. International aid agencies now argue that there is no longer sufficient grazing land or water to sustain a nomadic life, and the U.S. embassy's 1984 economic report said there was no question that Mauritania's centuries-old nomadic way of life has been irreparably damaged. Nevertheless, those who can survive as nomads still cling to life and try to continue on as best they can. In all these countries affected by the drought, Africans struggle to survive with a severe shortage of water, limited resources, and less opportunities for education than we have here. Their courage should be a lesson to all of us who have been blessed with advantages that we far too often take completely for granted. Some of us panic at the mere thought of missing a single meal, or consider ourselves unfortunate if we can't afford a new outfit of clothes. Some of us would even feel underprivileged if we couldn't own a yacht. As a nation of consumers, we pride ourselves on our "high standard of living", and are dazzled by a vision of "progress" that has led many of us to become obsessed with "success", this success being measured in terms of our wealth and possessions. Swept along in the tide, inundated by commercials in the media urging us to "buy more", we tend to forget that what we perceive as a normal way of life here in this country is very *rare* in most of the world. In Lesson 53 we mentioned that our country uses more of the world's natural resources than any other country; our "high" standard of living is more expensive than we may care to admit.

Objectively speaking, we may be accused of being selfish. How do we justify this use of natural

resources? Are we using them to better the lives of all our brothers and sisters around the world, to make the world a better place for all human beings to live in? Or are we using them to add to our own comfort, and patting ourselves on the back for our technological marvels, choosing to forget that millions of people in the world are still hungry? We have a right to survive, to secure the things that we need for our survival in this world—this is true. But if we already have 6 pairs of shoes and find ourselves gazing longingly into a store window at "just one more pair" we might stop and ask ourselves why we want to have *more* than we need. What is it within us that keeps us unsatisfied? Why do we never seem to have enough?

We've trailed a bit off the subject of water here, but it is time to see ourselves honestly in the mirror. It is time to appreciate the things that we *have*, because it is too easy to forget where all these things come from if we don't stop for a moment to realize how precious water and *all* our natural resources are, and to do everything in our power to appreciate them and conserve them all, *before* "the well" runs dry.

3. Ecology And Climate

3.1 Deforestation

The earth's remaining forest cover is being destroyed by human exploitation at an almost unbelievable rate: about 50 million acres a year, or 50 acres per minute. Trees are cut down by hungry people to get fuel or a few more crops off demineralized jungle soils, and the lumber business takes its own heavy toil. *Our forests and jungles must be saved*. Our rain forests have been called "the lungs of the earth", because so much of the earth's life-giving vegetation is contained in them. The present level of carbon dioxide over "normal" levels will increase 50% in the next decade. Many jungles are now living off the minerals in the decaying wood of dead trees, but they are usually in areas of high rainfall, and if minerals are added to the decaying organic matter, the trees will increase their growth rate and be immensely valuable in taking up and storing carbon from the atmosphere.

When water evaporates, oxygen is released into the air. Photosynthesizing plants are also a source of oxygen; leaves of the trees absorb carbon from the air and produce oxygen, releasing it into the air. We are disturbing the whole oxygen-carbon dioxide balance of our biosphere with our unwise activity.

Volkswagen Foundation has about 300,000 acres of former virgin forest land in Brazil, that is now used for an expanding cattle export operation involving *deforestation* at an average 13,000 acres per year (Grainger, 1980). Weyerhauser Corporation has 6,000 square kilometers of timber concession in the fragile rain forests of Indonesia (Myers, 1979).

If the jungles are not saved, John Hamaker says we have no chance at survival, and that they cannot be saved unless croplands of starving people are *remineralized*. Rain forests have been virtually eliminated from most parts of West Africa, Southern Asia, and the Caribbean. The world's forests are also affected by climatic extremes, soil degeneration, insects, diseases, worsening climate, air pollution and acid rains —fires also ravage our forests, especially in dry seasons and times of drought. As more forests burn, a *cycle* of destruction actually takes place, because forest fires contribute to adverse conditions that, in turn, accelerate the destruction of *more* forests. In forest fires, not only are more precious trees lost, but destruction occurs on all these levels:

- climatic stress (including record heat and drought)
- when trees burn, carbon dioxide increases in the atmosphere, so pollution—and acid rain—are

increased (they're already caused by burning fossil fuels and by auto/vehicle *and* industrial exhausts/emissions)
- deforestation and spreading deserts
- chronic insect and/or disease epidemics

Data on tropical forest fires is scarce, but it is reported that the nutrient-poor soils and highly-carbonaceous (mineral-poor) vegetation there burns quickly when moisture is withheld for a time. Wide-scale drought and acid rains not only lead to destruction of forests; they can also lead to more tropical forest fires. At present rates of human deforestation and desertification, most researchers say these forests are scheduled for virtual extinction in 15-30 years.

The April 1961, *American Forests* magazine warned of the explosive fire situation building up in U.S. forest lands—this was already 23 years ago.

	1964-1975	**1976-1978**	**% Increase**
Average # of fires per year	119.000	207,000	74%
Average total acreage burned per year	2,720,000	3,612,000	33%

"War Technology Comes to the Forests", by J. A. Savage, was printed in Friends of the Earth's *Not Man Apart* (December 1980), and described how the U.S. Forest Service is adapting technologies used in Vietnam to "modern" silviculture. In addition to the arborcide Agent Orange, flame-throwers and bombs of napalm-like jelly are used to achieve a "clean burn" of all the "debris" left after clearcutting. With these methods, no "slash" (from the slash-and-burn technique) is left, only "charred dirt". I assume their "clean" overlooks the damage to the environment and toxicity of the chemicals involved. In 1984, nationwide publicity of Vietnam veterans who had been exposed to Agent Orange revealed its effects in victims and their children; I hope the U.S. Forest Service isn't making more victims.

American Forests (March 1969) said that in a few years *all varieties* of trees were dying in a tract of forest in the Adirondack Mountains, except for hemlock and tamarack. Insects that attacked the trees multiplied greatly in the same span of time. The same thing that happened to this forest land is happening in all of the forests and jungles. The last of the minerals have come up in the forest lands, as in the croplands. Over the last 30 to 60 years, the finer fraction of used rock has been turned into subsoil, greatly reducing the surface area, and therefore, protoplasm production. Because these compounds build health, and resistance to disease and insects, the trees become easy prey to parasites. Acid rain (heavy in the northeastern states) has wiped out the last of the carbonates, resulting in excessive acidification of the soil. The lakes of that region have also been acidified. When acidity of water and soil drops below about pH 5.5, it begins to kill off various kinds of microorganisms. Only a few acid-tolerant organisms can survive, and only a few acid-tolerant trees and plants can survive on the poor quality and quantity of protoplasm which the soil provides. No amount of pesticides can stop this dying in a forest—only immediate aerial remineralization can save what's left of it.

In September 1961, W. Schwenke presented a paper on "Forest Fertilization and Insect Buildup". The paper described work done in the previous nine years at the Institute of Applied Zoology at the Forest Research Center, Munich, Germany. The work was based on the observation that forest parasites had greater population density on poor forest soil than on more fertile forest soil, and on the observation that forest soils can be improved by fertilization. They used 1/2 to 1 1/2 tons per acre of limestone plus a light application of NPK. This minimal soil remineralization cut parasite population from 30 to 50%. On some of the oils the effect was still observable nine years after the application. The increase in growth rate produced a value hat far exceeded the cost of fertilizing the soil. Limestone probably has a broader range of elements to support living organisms. This was shown by the observed fact that the lasting effect of the fertilization depended on the minerals that were in the soil *before* fertilization.

Severe deterioration of tree foliage and declining tree growth are also being observed throughout the Ohio Valley (AP news, April 16, 1984). The damage is a result of air pollution more acidic than the acid rain believed to be destroying freshwater life in the Northeast, according to a scientist who studies the valley trees. Dr. Orie Loucks said the decline can best be explained by the *cumulative impact of over 20 years of stress from a combination of air pollutants*. One important pollutant was the sulfate emitted from power plant and factory smokestacks. The acidity of the sulfate particles exceeds that of battery acid, he said. The major difference between the air quality of the Ohio Valley and that in the Northeast, he said, is that the sulfate content of the air is significantly higher in the Ohio Valley region (which includes Ohio, Indiana, Pennsylvania, West Virginia, and Kentucky). For some years forest deterioration has been reported in parts of the Northeast and other areas of the world—now Loucks has found that tree damage may be even more severe in the Ohio Valley, where there is a heavy concentration of coal-burning power plants that lack devices to clean emissions. The region is also believed to be he source of much of the acid rain now falling over the Northeast and Canada.

States in the Ohio Valley have been resisting legislation aimed at curbing acid rain through programs requiring modifications of power plant smokestacks, because such measures would mean higher costs for public utilities—but it's now obvious that the cost to *life* is far greater in the long run. In August 1984, New York became the first state to pass a law to curb acid rain, with legislation designed to reduce smokestack emissions 30% in the next decade. State environmental officials said the cost of the program, including pollution control devices, would add from $2.40 to $4.80 to the monthly utility bill for the consumer by 1991. Which of us would not gladly forfeit the price of a movie or a few magazines, if it would mean better air quality for everyone?

As we said, acid rain also comes from sulfur dioxide from lignite and coal-burning power plants and nitrogen oxides from auto exhausts and factories. It changes chemically in the atmosphere before falling to earth, killing freshwater life and damaging crops and forests. Acid rain has destroyed fish populations in 200 lakes in the upstate Adirondacks (many lakes have become so acidic that no life can exist in them) and, as we said, has damaged millions of acres. Congress must adopt legislation to require a nationwide reduction of 10,000,000 tons of emissions.

Lewis and Grant (*Science*, 1/11/80) also present some frightening statistics. On the Colorado section of the Colorado Divide where there is very little industrial pollution in the direction of the prevailing wind, the pH of all precipitation still dropped from 5.43 to 4.63 in just three years. Neutral pH is 7.0. Hamaker says that since the CO2 curve is almost vertical at the year 1995, we can go back 20 years to 1975 for the start of the 20-year critical period (to be mentioned in a moment) and not be off by more than a couple of years. The pH then must have been about 6.

Acid rain occurs "naturally" in some places—in the Canadian arctic, natural fires in exposed lignite coal beds produce tremendous amounts of sulfur oxides. These chemicals fall to earth, rendering nearby lakes as acidic as lemon juice. Studies of the Greenland ice cap show that acidic depositions on the earth's surface have been rising since the beginning of the industrial age, with the greatest increase occurring since the 1940s. Central Europe seems hardest hit. Forests are dying throughout Czechoslovakia, Poland, and East Germany. In West Germany, 3,700 acres of woodland died from 1978-1983, and 200,000 acres were seriously damaged, the most vulnerable being dense, pure stands of conifers between 20 and 40 years old that will probably not survive another 10 years (Bernhard Ulrich, German biochemist, 1983). Mr. Ulrich estimates that almost 5,000,000 acres of German forest soils are at the threshold where toxic aluminum will begin its lethal work. Industrial emissions *drift* from England to Scandinavia. The industrial Ruhr and Rhine area in Germany affect most of central Europe, and Russia (the largest burner of sulfur-bearing fuels) is also polluting Finland. America's industrial Midwest helps render the rain acidic in virtually every state east of the Mississippi; much of the Midwest's emissions join those from Canada, acidifying eastern Canada and threatening its fish and forests—two of its chief resources. In the U.S., only some of the Rocky Mountain states and parts of the Southwest enjoy healthy rains of pH 5.5 or more.

Crops and temperate zone vegetation cannot grow on acidic soils, so the large number of dead and dying

trees in our forests is attributable both to increasing soil acidity *and* decreasing quantities of available elements. Dead forests burn easily with a hot fire which oxidizes large quantities of atmospheric nitrogen. Lewis and Grant found that the oxides of nitrogen were dominant in the acidic precipitation. The more trees die and burn, the more the soils become acidified and the more trees must die. There are also a number of mildly acidic gases released from burning wood. These, plus the acidic gases from volcanism (volcanic power or action), are nature's way of bringing on glaciation. Man's fossil fuel fires are also a big factor in the destruction.

Belgian scientist Genevieve Woillard showed that the final changeover to sub-arctic climate and vegetation (to be discussed later) took only 20 years at previous interglacial-to-glacial transitions, as recorded in the undisturbed pollen deposits of Grand Pile, France. In Woillard's study, the change in vegetation was from hazel, oak, and alder to pine, birch, and spruce—that is, a change from warm-weather to cold-tolerant trees. But even more significant: this change is from nut-bearing trees to trees that can't yield a proteinaceous crop. That translates to mean a decline in soil minerals to the point where there are insufficient microorganisms in the soil to grow proteinaceous trees.

It now appears that the 20 years for the change in vegetation can be shortened because of industrial pollution; we are actually speeding up the deterioration process on all fronts, by the sum total of all our environmental errors. Hamaker said: "Judging from the CO2 curve, we are actually 5 years into such a period."(This was at the time his book was written.)

The Amazon forest is the largest tropical rain forest left in the world, but it is paying a heavy price for "progress". Deforestation of large tracts (such as Volkswagen's aforementioned tract) is causing a change in the region's climate, something climatologists have warned of for some time. A change in the region's water balance seems to be the result of increased runoff due to deforestation. If so, the long-predicted regional climatic and hydrological changes expected as a result of Amazon deforestation may already be beginning. Increased flooding is the first sign of damage to the Amazonian ecosystem. A heavily-deforested area has developed along the edge of the mountains in upper Amazonian Ecuador and Peru during the past 10-plus years, the result of large slices of forests being cleared for roads, housing, and other development, all of which are exposing the land to increased runoff and erosion. Scientists have found that runoff is increasing in the area while rainfall patterns remain the same; this is caused by interference in the process of transpiration—trees take up moisture that falls and send it back into the air. Now that the trees have been eliminated, the recycling process has been curtailed to an extent that the report warns "might eventually convert much of now-forested Amazonia to near desert." Note: While in most areas (such as the North American Great Plains or Western Europe) most of the rainfall represents moisture blown in from the sea, *about half of the Amazonian rainfall is water that is recycled within the basin*. Thus, in tampering with the balance of ecology in the Amazon rain forest, one tampers with its rainfall cycle as well.

Since population and farming are concentrated along the Amazon's seasonally-flooded river margins, scientists warn that the magnitude of damage is potentially great, and say that the "rapidity with which relatively-limited forest destruction (which has since *increased*) appears to have altered the Amazonian water balance, suggests the need for planned development." This is obviously an *understatement*—planned reforestation *and* remineralization are also needed to save the Amazon area, before going about any so-called "planned development". When viewing the earth via satellite, you can literally see the moisture that swirls and sweeps outward from the Amazon area—it covers such a large area that it is seen as a giant moving form that takes on a life of its own—rapid development in the Amazon not only tampers with local ecology, it also affects areas farther away that would normally be affected by these huge, moving atmospheric systems of the Amazon.

Throughout the Third World, unchecked erosion is washing away valuable topsoil. Reforestation could stop the process, aid in CO2 removal, and aid rainfall cycles—it must be a top survival priority. Because it can take years for reforestation's results to be felt, local governments and villagers have been reluctant to take on what appear to be long-term, labor-intensive projects, but they are failing to realize what failure to do so will mean to their ecosystems.

Researchers are working on what they call a "miracle tree", the *Leucanna leucocephela*, which is an extraordinarily fast-growing, all-purpose, self-fertilizing tree, used for both fodder and timber. Under ideal conditions it reaches a 10-inch circumference in one year.

Arbor Day began in Nebraska in 1872, when more than one million trees were planted to help prevent erosion and moisture loss in a state with few trees. Within two decades, 100,000 acres had been turned into forested preserves. Arbor Day is now a legal holiday in four states and is celebrated in all the states, but please don't wait for Arbor Day to plant trees—do so whenever you can. Fruit trees are especially needed everywhere.

Over 100 countries grow tobacco; flue-curing about 2,500,000 tons annually uses about one hectare of trees for every ton, amounting to about 12.5% of 18-20 million hectares of trees cut yearly, which means about 1 in 8 trees is axed just for drying tobacco! Cropland used for tobacco should be used for growing food instead.

3.2 Carbon Dioxide—Global Climate Changes—Weather Patterns

The increase of carbon dioxide in the atmosphere is our most urgent problem. John Hamaker drew a carbon dioxide curve projection in 1979 and said that unless we gained control of the curve shortly after 1985, by 1990 the rate of breakdown of the environment would be occurring much faster than we could repair the damage. However, in order to gain control by 1985, we would have had to start in 1980 to have a fully-operating program of soil remineralization, pollution reduction, and so on. As of 1985, few people took seriously what the curve was saying—nevertheless, Hamaker hasn't given up hope for humanity's survival, even though he's also considered the possibility that "if we were to start to work in the next few months, we could have less than a 50% chance of success". He's written countless letters and says three world science organizations finally agreed to meet in 1985—he thinks action is long overdue, with "nature just beginning to show her teeth". While we wait around for statistics and more data, the power of centralized wealth is holding us to a system of soil destruction. World leaders, concerned with what they must do to get re-elected (if they are indeed elected), merely serve the interest of a wealthy *minority* that controls an economic system that is ruining our lands, keeping millions of people poor and/ or in debt, keeping our countries in debt, and threatening our very survival with destructive weapons, aggressive foreign policies, and decisions that continually compromise the quality of our environment.

The Global 2000 Report to the President was commissioned in 1977 by President Carter and finally released in July 1980, as a three-volume work of over 1,000 pages. The report's findings aren't represented as predictions, but as depictions of conditions likely to develop if there are no changes in public policies. Some of its findings on CO2 were:

- CO2 emissions will increase to 26 to 34,000,000,000 short tons per year, roughly double the CO2 emissions of the mid-70s.
- 446,000,000 hectares (each is 2.47 acres) of CO2-absorbing forests will be lost.
- Burning of much of the wood on 446 million hectares will produce more CO2.
- Decomposition of soil humus will release more CO2.

By June 1979, the percent of increase of CO2 over an assumed "normal" level of 290 ppm was about 15%. In 1985, it could be 18%. By 1990, it could be 22% (50% more than it is now). Yet we go on bringing carbon out of the ground and putting it into the atmosphere.

John Gribbin (*New Scientist*, 4/9/81), noting the intensification of worldwide forest destruction and fossil fuel combustion, reports that the present annual CO2 increase has jumped to 2 to 4 ppm, and "is increasing rapidly today, in 1981". (Hamaker's CO2 curve projection could even prove conservative.)

"The Role of CO2 in the Process of Glaciation", published in April 1980, was written as a concise explanation of the glacial process which could be understood by the U.S. Congress, at a time when the

CO2 problem was just being recognized by some of its members. It appears in Hamaker's book, and refers to the relationship that has been virtually never considered by the hundreds of researchers of glaciation, starting with the first "Great Ice Age" theory of Louis Agassiz in 1837 (Imbrie and Imbrie, 1979).

This excess carbon dioxide is causing what is known as "the greenhouse effect "because carbon dioxide behaves like the glass in a greenhouse, permitting the sun's rays to reach the earth, but not allowing the heat to escape. The effect is like that of a "thermal blanket" around the globe. As a result, some scientists think that the earth will become warmer, but others, including John Hamaker, say that it is now getting colder. *All* scientists now agree that carbon dioxide levels are too high, and with acid rain, forest fires, deforestation, and trees dying from soil demineralization, CO2 levels continue to *increase*. Nature will complete her necessary cycles and go about her own self-healing processes, just as our bodies do. We'd do well to understand her cycles and healing crises better, and offer help instead of waiting for chronic illness to set in. We tend to forget that the earth is very much alive, and a living being/entity (albeit a *large* one!)—it regulates itself as surely as our bodies do. Because we need the earth to survive, its state of health is very fundamentally—and really—speaking, *as important as our own*.

I'll present both the warm *and* cold predictions to show how complex climate "analysis" becomes—all environmental factors interrelate to affect it. Having considered their total impact on our ecology and weather, heard both sides (warm/cold) of the story, and watched worldwide weather trends these past years, my intuition tends to believe scientists who say the world is cooling. In any case, we can't deny that our planet is being manipulated (and often assaulted) on all sides *daily* by millions of its inhabitants. Some of these assaults are very *serious*; we discussed long, periods of time that some radioactive waste materials remain dangerous in Lesson 53—this is only *one* example. Life Scientists know of chemical medicines adverse effects in the body. Can you imagine how our planet's health is affected and weakened by millions of daily assaults on its body?

The saying "do unto others as you would have them do unto you" is not just a suggestion on how to be "nice". It says, in essence, that *what* you do unto others you do unto *yourself*—more and more we see how true this is. Now we must also *do unto our planet as we would have our planet do unto us*, for what we do to our planet, we do to *ourselves*.

3.3 Warmer or Colder?

Before continuing, let's clarify the fact that scientists who see the world as cooling do not necessary dispute the greenhouse effect's warming potential in and of itself—some see a preliminary warming as part of an "energy booster" or catalyst in the Ice Age transition process: the tropics do become hotter/drier as precipitation increases farther north, but increased cloud cover and other factors, to be discussed later, lead to increased cooling conditions.

Let's take a look at the two opinions ... warmer or colder:

In the fall of 1983. the federal government, based on an Environmental Protection Agency report, said that a "dramatic warming of the earth's climate could begin in the 1990s because of the greenhouse effect, with potentially-serious consequences for global food production, changes in rainfall and water availability, and a probable rise in coastal waters". The report said that "levels of CO2 in the air created by burning of fossil fuels could result in an increase of 3.6 degrees Fahrenheit by the middle of the next century and a 9-degree rise by 2100, representing an unprecedented rate of atmospheric warming".

"It's going to have a very profound impact on the way we live," said John Topping, staff director for the EPA's office of air, noise, and radiation. "Some of the effects will be beneficial; some will be detrimental. But our ability to accommodate them will depend much on our planning beforehand. Temperature rises are likely to be accompanied by dramatic changes in precipation (more rainfall in some areas, more drought in others) and storm patterns and a rise in global average sea level," the study said. "As a result, agricultural conditions will be significantly altered, environmental and economic

systems potentially disrupted, and political institutions stressed."

Stephen Seidel, one of the authors of the report, said that milder winters and much warmer summers by the 1990s may no longer be unusual. The report said the trend will occur regardless of what steps are taken to reduce the burning of fossil fuels.

The study said a warmer climate would raise the sea level by expanding the oceans and by melting ice and snow now on land. An increase of only two feet "could flood or cause storm damage to many of the major ports of the world, disrupt transportation networks, alter aquatic ecosystems and cause major shifts in land development patterns". The warming is expected to be greater at the North and South Poles and less at the equator, the EPA said. John Hoffman, head of strategic studies for the agency, said "New York City could have a climate like Daytona Beach (Florida) by 2100".

A major report issued in 1983 by the National Academy of Sciences said that the approaching warming of the earth "is reason for concern, not panic". The report warned, however, that a warming trend and decreased precipitation could "severely affect" the Texas gulf, Rio Grande, upper and lower Colorado River regions; California; and other Western regions. One projection in the report shows a possible reduction in water supply of nearly 50% when the full force of the warming phenomenon is felt after the year 2000. The tone of the academy warning was less urgent than the EPA's, stressing the need for "more intense research". However, the academy found that since (in their opinion) there is no politically or economically realistic way of heading off the greenhouse effect, strategies must be prepared to adapt to a "high temperature world." The EPA report said that even a total ban on coal would only delay the process for a few years, and said that, because the CO2 in the earth's atmosphere retains heat rather than permits it to escape into space, thus creating the greenhouse effect, the buildup of gas will be accompanied by a rise of global surface temperatures, most likely in the range of 2 to 8 degrees F. These projections are roughly similar to those in the EPA report; it is expected that this rise will be accompanied by "rapid climate change, including changes in rainfall patterns, as well as a rise in the sea level of over two feet".

Some additional notes on the greenhouse effect are of importance:

Recent investigations have established that other man-made pollutant trace gases may increase the greenhouse effect by another 50% (Flohn, 1979; Kellogg and Schware, 1981). These gases come primarily from burning vegetation, release of industrial halocarbons (freons), and the denitrification of nitrogen fertilizers in the soil. *The Greenhouse Effect* by meteorologist Harold Bernard, issues a strong warning that the heating effects alone will likely be devastating to humanity due to increasing climatic stress; agriculture in particular will suffer greatly. He cites increasing storminess with tornados, hurricanes, floods, searing "dust bowl"-type droughts, water depletion, and massive forest fires if we continue on the fossil fuel route, presenting a whole bank of reasons against doing so.

The last few years *have* seen dramatic changes in precipitation—more rainfall in some areas, more drought in others— but these are also part of the weather forecast given by scientists who say the world is cooling. Apparent warming trends could be superceded by *cooling* trends in the long run, if we are due for transition into a glacial period.

Systematic measurements of atmospheric CO2 began only as late as 1958 (Calder, 1975). Most climatologists seem fond of repeating the dangerous oversimplification of CO 2's greenhouse effect, that is, that the earth will warm up as a result.

In a 1977 paper, Hamaker asked, "How Rapidly is CO2 Increasing in our Atmosphere?" In 1977, a National Academy Sciences panel on energy and climate provided a frightening statistic (Charles Keeling, *Science*, 9/2/77). Keeling said there'd been a 13% rise since the Industrial Revolution began. Alarming is the fact that five of this 13% had occurred since 1962". That same *Science* article discussed the *oversimplified* computer models of CO2's "general warming" effect, and stated that there are some scientists who "privately suggest" that because of "complex feedback phenomena", global *cooling* could result.

Hamaker says that even if the *average* temperature of the atmosphere is getting warmer, it is false to assume polar ice will melt and temperate zones will move toward the poles. According to Hamaker, "the experts have given us a time scale for weather changes that is longer than we have. Many things are operating at once to affect climate. They all have long overlapping time lags so that we cannot say that this happens, then this, and then this. But the first stage of glaciation, which is initiated by a change from temperate zone to northern latitude types of trees, and by dying of tropical forests, is here *now.*"

Hamaker says "the theory that the world will get warmer is based on the absurd idea that the earth's average temperature depends solely on the sun's energy and the heating effect of atmospheric CO2. On that basis these scientists have projected a rise in temperature in the next century when the CO2 has doubled, so they have drawn a line tangent to the recorded curve and ending up in the next century." He disagrees with the projection, saying that nature is clearly drawing a curve that is constantly increasing at an *accelerating* rate of increase, and the scientists have merely decided that nature must change her ways to suit their predictions.

The time to stop the onset of glaciation is before it starts, because it starts with the destruction of agriculture. Hamaker says that we must act now, before our technological capacity to remineralize the soil is lost in the chaos of a world of starving and dying nations. As we said, climatic cycles and factors may overlap, but we *can* identify a point in the whole climate cycle at which the temperate zone climate is destroyed and we stop eating! We *can* chart the CO2 content of the atmosphere and know whether we have enough minerals in soil and water. The CO2 curve is showing us that the time of no temperate zone could be approaching. We must remineralize the world's soils and put carbon back into the earth as fast as we can to reverse the CO2 curve and bring it back to a safe level.

Hamaker says that scientists predicting a warming also aren't taking into consideration the role of life in and on the soil in demineralizing it in a period of 10,000 to 15,000 years, depending on the amount of ground rock supplied by the last glacial advance, nor do they all understand the earth's tectonic system and its role in determining the weather. The climate cycle is a by-product of the *entire* life system, all of which rests on the expenditure of atomic energy in the tectonic system. There are two energy systems which are powerful in comparison to other factors (such as sun spots, Milankovitch's theory, or the alignment of planets in space)—the effects of these other factors may be noted, but they don't substantially alter the glacial process—both of the *primary* energy systems use the energy in the atom. *One is the sun and the other is the tectonic system*.

The earth constantly intercepts the sun's energy. If the energy incident to the earth at the higher latitudes is deflected into space instead of being absorbed at ground level, the total amount of energy available to warm the earth is decreased by that amount. During a glacial period the total amount of sun energy reaching the earth is decreased because the CO2 (from the tectonic system) directs a heavy cloud cover to the polar latitudes. The clouds have a very high albedo, that is, ability to reflect the sun's rays back into pace.

The tectonic system constantly removes materials from the mantle of the earth, separates the compounds containing a balance of elements useful to living organisms, and moves them into the mountains or into the atmosphere. Compounds containing elements not required for life processes are consigned to the core or are recycled to build the basic ocean floor at the ridge.

Everything on earth is totally dependent on the tectonic system; if it were to run out of fuel, the earth would be cold and lifeless like Mars. Climate is directly controlled by the discharge of carbon and sulfur oxides by the tectonic system. Now that mankind has a hand in adding CO2 to the air (and making *other* environmental errors), climate is *also* affected by the human factor. There is a scarcity of minerals on the land and in the sea, further contributing to the CO2 buildup in the atmosphere as more and more CO2 is supplied by the tectonic system and less and less is put back into the earth's crust by the living organisms. All these factors overlap and affect climate. We *can* say that the minerals (those available to microorganisms) and the carbon released by the tectonic system can be monitored—and thus, theoretically, can be *controlled* to some extent—we still have much to learn in this area, but we can and

do have an affect on climate.

The burning of temperate zone vegetation will carry huge quantities of CO2 into the atmosphere. In the zones of latitude where the sun's rays are most intense (the equatorial region), CO2 holds the sun's heat at the surface of the earth, increasing surface temperature and providing the energy to increase the evaporation and to move the massive cloud cover to the polar regions; CO2 has no heating effect at the poles in the winter when it's dark 24 hours a day. The warm, demineralized ocean can't take up the CO2 as fast as it is being put into the air, and decreasing plant life and less trees also mean less CO2 is being converted. We cannot allow the CO2 increase to reach the point of no return—that is, the increase in CO2 from the tectonic system *and* our own input must not be allowed to exceed the capacity of the *remaining* forests and sea life to remove the CO2. When the minerals are too few to support enough life to hold down the CO2 level, the level begins to rise and the death of the temperate and tropical zone forests swiftly initiates the air flow pattern which brings glaciation to polar latitudes and extreme, killing heat and drought in between.

When air gets hotter, its atmospheric pressure decreases. It's then easier for the cold air moving d own over a cold land mass to displace the warm equatorial air and force it to move poleward over the warm ocean to replace the cold air moving toward the equator. This is the normal air circulation pattern impressed on the west winds. During glaciation, when there is an extensive ice field, there is no summer because the refrigerated air from the ice field maintains the temperature differential required to carry the clouds to the northern latitude. Thus there can be unusually large masses of hot air in the equatorial latitudes and unusually large masses of cold air in the polar latitudes. Glaciation, or for that matter, anything else on earth, can't take place without an expenditure of energy. Without a buildup in CO2 and hence temperature, glaciation cannot happen.

Hamaker says that the average temperature at the start of a glacial period must be higher than the interglacial temperature, and must remain higher until the cooling effect of the ice sheets starts bringing it down, but says this won't help agriculture: the southern temperate zone will have excessive heat/drought; northern/temperate zone: summer freezes and frosts; cloud cover lowers the temperature and increases the quantity of cold air which flows south over the land masses. With early cold snaps and longer, colder winters, the temperate zone will become a part of the subarctic zone. The summer frosts/ freezes, short-growing seasons, drought and violent storms, rapidly diminishing soil minerals, and increasing rain acidity will destroy the world's grain crops; we can't grow grain in the subarctic. Growing seasons have already been shortened and interrupted by freeze damage. (The local areas to survive will be the few near the equator that are blessed with a constantly renewed supply of basic minerals sufficient to maintain a neutral soil in spite of the acidic rains, says Hamaker in *Survival of Civilization*.) We've already seen indications of these patterns. He says we can stand cold winters for some time, but not if they carry over into summers to destroy crops and trees. Cold waves, just a few degrees lower in temperature, can cause major crop losses in Canadian and Eurasian grain crops that are at the latitude of Michigan or farther north. Hamaker says food production in the northern hemisphere in 1980 had lost about 20% of potential because of adverse weather (drought/ heat in the U.S.; cold, wet weather on the Eurasian continent; and, in the southern hemisphere the growing season started with drought in Australia, Africa, and South America). He fears that famine could begin soon, that it could be a few years away; 1978 and 1979 fruit and vegetable losses in California, Texas, and Florida, as well as wintercrop losses in 1983/84, show what could happen to crops in the years just ahead.

Anyone interested in studying the whole glacial process in more depth is urged to read Hamaker's book —there is an entire section on the tectonic system, plus more details on the role of CO2 in glaciation and many other facts and figures on the glacial process, including the period of glaciation itself. Our space in this lesson requires us to focus more on the *transition* period from interglacial (warm) to glacial (cold) so that we may become more aware of signals observable during a change to glaciation.

Let's take a look at what some other scientists who foresee a *cooling* have to say about the energy expenditure required for glaciation; we've seen that scientists agree, in general, on some information about past glacial periods and our present interglacial, but they don't all agree on *why* glaciation

happened. What force could bring such a change about? We've said that Hamaker saw the greenhouse effect as occurring *differentially*: the increasing temperature differential between warmer (hotter/drier) and colder (colder/ wetter) latitudes has taken on a life of its own and is accelerating the whole process. When the supply of minerals ground from rocks by the last glaciation is used up in the soil, this exhaustion of soil minerals by the life in and on the soil initiates a whole chain of events which results in restocking the soil with minerals and a new proliferation of life.

David P. Adam of the U.S. Geological Survey, a longtime student of glacial periods, has emphasized that to understand their causes, one must solve the "energy problem" they present. His *Quaternary Research* paper (1976, "Ice Ages and the Thermal Equilibrium of the Earth (II)") shows that an essential requirement to begin and sustain a glacial period is an increased transfer of (excess) energy towards the glaciated regions, and that energy is in the form of moisture. This is of course precipitated largely as snow, thus forming the initial perennial snowfields and subsequent ice sheets. He states that some increased energy source must therefore be invoked to sustain these vast energy transfers, yet he does not consider in his paper the fact of excessive CO2's solar heat-trapping effect as the possible "booster" for providing this increase of effective energy, which, as Adam points out, is "required to fuel a continental glaciation".

In a personal communication to Hamaker, David Adam agreed that Hamaker's theory (CO2) indeed fulfills the requirements of providing the glacial energy fuel. Yet, surprisingly, David knew of no one in the history of modern Quaternary research who had postulated a CO2-glaciation relationship, perhaps due to the relative state of infancy of modern CO2/climate studies, but he said there was one well-respected climatologist who had presented an explanation of the basic glacial process very similar to Hamaker's, Sir George Simpson of Britain. He was first to point out that the glaciation that characterizes an ice age can't come about by a general cooling of the earth's atmosphere—because some source of *increased* energy is required to transport poleward the huge amounts of moisture which make up the glaciers. Most climatologists now agree, because a decrease must lower the mean temperature of the earth's surface (especially in the tropics), decrease the equator-to-pole temperature gradient, and distinctly lower the moisture content of the atmosphere. He realized that it's obviously paradoxical to expect fulfillment of certain fundamental requirements for glaciation (*intensified* equator-to-pole temperature gradients, *stepped-up* atmospheric circulation, and *increase* of poleward heat and moisture transfer) with a declining surface temperature, especially in tropical regions.

John Hamaker, while unaware of Simpson's theory, was apparently the first to correlate the basic heating and circulation principles operating at glacial initiation with the soon-to-be-infamous" *differential* greenhouse effect. Other recent warnings on this differential heating effect have come from Lester Machta (head of National Oceanic and Atmospheric Administration (NOAA) Air Resources Labs), saying that CO2 could indeed cause the massive cooling cloud coverage and cooling at the poles, and from Justus (1978) of the Congressional Research Service: "If the earth's temperature rises, the water vapor content of the atmosphere is likely to rise. A rise in water vapor would quite likely increase the fraction of the globe covered by clouds. Such an increase could cause the amount of primary solar radiation absorbed by earth to fall." In a document prepared for Congress ("Weather Modification: Programs, Problems, Policy, and Potential," Chapter 4), Justus says: "In geological perspective, the case for cooling is strong. ... If this interglacial age lasts no longer than a dozen earlier ones in the past million years, as recorded in deep-sea sediments, we may reasonably suppose that the world is about due to begin a slide into the next Ice Age." (p. 153.)

Hamaker says that failure to remineralize the soil will cause continued mental and physical degeneration of humanity and quickly bring famine, death, and glaciation, in that order.

The majority of the world's people fall into one of these categories: those who are aware of problems and take action; those that are angered by problems, but talk or worry about them and don't *take action*; those who just give up hope; those who trust in the system, right or wrong, problems or no problems; those who are just plain indifferent to problems; and even those who are unaware that problems exist at all!

Most people probably think that the last ice age was "a million years ago", but the fact is, it ended only about 10,000 years ago—a few seconds in geological time. Everything that we know in terms of our "civilization" has taken place in that brief span of time since the earth last warmed up. The potential global climate changes that face all of humanity could re-arrange everything on the planet, and affect every living creature on earth more than any other ecological issues in question—*even beyond* such crucial concerns as world peace—for the issue here is whether we want to have a world *at all* in which to *live* in peace. We *must* make the ecological changes necessary for survival. Because most of the subsoil and topsoil of the world have been stripped of all but a small quantity of elements (by time, water, erosion, chemical fertilizers, pesticides, and so on), Hamaker says man can stay on this earth only if the glacial periods come every 100,000 years to replenish the mineral supply—*or if we get smart enough to grind the rock* ourselves and apply it everywhere on soil that is depleted. Glaciation is an acceleration of the normal process of using evaporated water to carry excessive heat energy from warm zones to cold zones, and the greenhouse effect (of an increase in atmospheric CO2) is to increase cloud cover over polar latitudes. The clouds have a cooling effect as well as providing the snow for glaciation. The energy is dissipated in arctic space. Glaciation occurs whenever the soil minerals left by the last glacial period are used up and the plant life (forests are the major factor in CO2 control) can no longer regulate the carbon dioxide by growing faster in response to its increase in the air.

3.4 The Glacial-Interglacial Cycle

The glacial-interglacial cycle was revealed by numerous workers in many fields of Quaternary research as of the 1970s. (The Quaternary is the present geological period including the Pleistocene epoch and the Holocene—recent—epoch, the present interglacial in which we now live). A National Academy of Sciences (NAS) publication, *Understanding Climate Change* (1975) says: "The present .interglacial interval—which has now lasted about 10,000 years—represents a climatic regime that is relatively rare during the past million years, most of which have been occupied by colder, glacial regimes. Only during about 8% of the past 700,000 years has the earth experienced climates as warm or warmer than the present. The penultimate interglacial age began about 125,000 years ago and lasted for approximately 10,000 years. Similar interglacial (warm) ages—each lasting 10,000 (+- 2,000) years and each followed by a glacial (cold) maximum averaging 90,000 years—have occurred on the average every 100,000 years during at least the past half-million years. During this period, fluctuation of the northern hemisphere ice sheets caused sea-level variations of about 100 meters."

This NAS publication concludes that: "If the end of the interglacial is episodic in character, we are moving toward a rather sudden climatic change of unknown timing. ... If, on the other hand, these changes are more sinusoidal in character, then the climate should decline gradually over a period of thousands of years." All factors considered, Hamaker doesn't think we have that long.

Paleoclimatologists *agree* that the major warm periods (interglacials) that followed each of the ends of the major glaciations (cold periods) have lasted from about 10,000 to 12,000 years, and that, in each case, a period of considerably colder climate has followed immediately after these intervals. About 10,000 to 10,800 years have now passed since the onset of our *present* period of warmth, so the question certainly arises as to whether we *are* really on the brink of a period of colder climate. The 100,000-year cycle of glaciation is now recognized as occurring with regularity, so, technically-speaking, we could be due for another ice age "any time during the next 1,200 years". As we said, though, signs that signal the changeover or transition from temperate to colder climate are already in evidence, and increasing due to our environmental errors.

Most scientists are noncommital, but those who are beginning to express concern say that these signs mean that we may be much closer to the first stages of the next ice age than anybody would like to think. Let's review some of the signs we've already talked about:

We have already seen that the earth's total soil microorganism and earthworm populations have been dying back over the recent centuries and decades due to soil demineralization, and so the earth's plant

and tree life has been forced to die back—known as "retrogressive vegetational succession" in the literature of ecology. Deserts (now growing at a rate of 15 million acres per year) are generally a final stage of this retrogression process. Our abuse and neglect has reinforced this desertification, as it has deforestation. Soil demineralization (with acid rains accelerating the devastation) is causing the increasingly rapid sickening and dying of whole forests. The massive death and burning of the forests is signaling the "telocratic" or *end phase* of our present interglacial period. Svend Th. Andersen saw the broad picture of glacial/interglacial stages and said that the interglacials were stable intervals between the glacial stages of disturbance and chaos. The vegetation had a chance to develop until the new glacial released its destructive forces. He divided the *interglacials* (warm intervals) into four broad phases:

1. *Protocratic phase*. At the start of warm intervals, open forests of pioneer species entered—these were quickly-spreading trees and shrubs with unpretentious requirements to climate and soils. Birch, pine, poplar, juniper, and willow were most important in Denmark, Andersen's home.
2. *Mesocratic phase*. The soil had developed a high fertility, and plants of rich soils reached maximum frequencies. Immense forests covered great portions of the earth in the last mesocratic phase (from about 6,000 to 3,000 B.C.) Some of these trees, such as oaks, were reported to be often of remarkably large size; these are found preserved in now-degenerate treeless peat soils in England and elsewhere. The phase is dominated by trees such as elm, oak, lime, hazel, ash, hornbeam, and alder, growing on stable mull soils which Dr. Johannes Iversen (State Geologist, Geological Survey of Denmark), showed to eventually begin to retrogress. Iversen tried to find out at what point in the interglacial the retrogressive vegetational succession starts, and said it is "when the yearly disintegration of the plant debris no longer keeps pace with the fresh supply from the living plants, and consequently a layer of 'mor' (raw humus) is accumulated on top of the mineral soil". "Mull" humus has a richness of available minerals; "mor" is acidifying humus. He studied soil conditions and said that, from the point approximately 10,000 years ago commonly accepted as the beginning of our present (warm) interglacial, it took about 3,700 to 4,500 years for the first of the glacially-deposited raw mineral soils of basic or alkaline pH to "mature" and then go into a gradual "irreversible" degradation/depletion. Iversen says this degradation process is characterized by reduced soil organisms, earthworms dying out, and by the vegetation regression that comes when soil is depleted and lacks minerals. Andersen and' Iversen have similar descriptions of this process. In these mull soils, of roughly 6000 to 3000 B.C., the leaching of the soil salts is to some extent counteracted by the mixing activity of the soil fauna and the ability of the prevailing trees and shrubs to extract bases from the deeper soil layers and contribute them to the upper layers during the decomposition of their litter. However, a slow removal of calcium carbonate will bring the soils into a less stable state, where the equilibrium may be more easily disturbed. This leaching of calcium carbonate (lime) is shown to be so significant to the topsoil ecology because, according to Andersen, "the leaching of soil minerals other than lime will be insignificant, until the calcium carbonate has been removed". With this gradual leaching, the mull forest could not maintain itself, and with the lapse of time, caused itself a depauperization and acidification of the upper soil layers, which extended so far that the dense forest receded and more open vegetation types expanded. The changeover from mineral-rich mull soils to acidifying mor soil conditions begins in the mesocratic, and with the gradual demineralization of formerly-calcareous soils, growth of impenetrable hardpans and soil life die-outs follow. This creates *shallow topsoils* susceptible to drought or being easily swamped; and this infertile state leads to takeover by heathlands, peat bogs, and *trees with ability to survive on acidic soils*—spruce, pine, birch, poplar, etc.
3. *Oligocratic phase*. This condition becomes prevalent in this phase, and is brought on as a result of degeneration of soils. The increasing podzolization, characterized by increased demineralization and acidity, continues up through the telocratic (end) phase. (Podzolization is a process of soil formation, especially in humid regions, involving principally leaching of the upper layers with accumulation of material in lower layers and development of characteristic horizons; specifically, the development of a podzol. Podzol: any of a group of zonal soils that

develop in a moist climate especially under coniferous or mixed forests and have an organic mat and a thin organic-mineral layer above a gray leached layer resting on a dark alluvial horizon enriched with amorphous clay.)

4. *Telocratic (end) phase*. The final interglacial phase is the time when the demineralized soils begin to be removed. The rigorous conditions at the end of the interglacial are reflected by an increase in allochthonous mineral matter, no doubt due to increasing surficial erosion.

The information in virtually every textbook on soils, forestry, or ecology leaves no doubt that the present world civilization is at least deep into the oligocratic phase. Andersen's work also shows that the Scandinavian lakes and soils reflect a close parallel development from basic to acidic conditions—again, many thousands of lakes there, as well as in other parts of the world, are now already acidified into lifelessness from acid rain. Rapidly accelerating worldwide erosion rates are evident; the figure in 1981 was already 6,400,000,000 *tons* of topsoil lost per year to erosion.

These facts, along with increasingly rigorous conditions imposed by the weather since at least 1972, very strongly indicate that the *telocratic end phase* may indeed have begun. As we said, the final changeover to sub-arctic climate and vegetation has been seen to have been made in only 20 years in other interglacial to glacial transitions.

What other changes come with the end of a period of interglacial warmth? From studies of sediments and soils, George Kukla agreed that "major changes in vegetation occurred at the end of the previous warm period. Deciduous forests that covered areas during the major glaciations were replaced by sparse shrubs, and dust blew freely. The climate was considerably more 'continental' than it is now, and agricultural productivity would have been marginal at best." George Kukla and Julius Fink studied interlayered soils exposed in excavated brickyards of Czechoslovakia. Seventeen major cycles of glacial loess deposition (loess is mixed rock dust and silt ground by the glaciers and swept by the winds) and subsequent interglacial soil "decalcification" (and overall demineralization) over the last 1.7 million years were revealed. The interglacial soils are shown to have supported the deciduous forests native to northwest and central Europe until in some way they died off and gave way to the steppe vegetation of a chilled, wind-torn glacial desert with blowing dust. Loess always returns to cover the demineralized soils. Then, again, over the centuries, the loess becomes mostly consumed by the soil formation and development process.

The cycle of glaciation is complete when the supply of minerals ground from rocks by the last glaciation is used up and glaciation occurs again. Whereas plant life normally removes all excess CO2 from the atmosphere by growing faster as CO2 increases, it can no longer do so, since it gets its cell protoplasm from the soil microorganisms and, as we know, the microorganisms start dying too when insufficient elements are available to them.

A conference was held at Brown University in 1972 with paleontologists, sedimentologists, stratigraphers, paleoclimatologists, and others, entitled *The Present Interglacial, How and When Will It End?* They strongly confirmed the 100,000-year average glacial-interglacial cycle, and many stressed the fact that we should be at or close to the end of the present interglacial.

The search for causes of the Ice Age began over a century ago, and Hamaker says the answer literally lies beneath our feet: progressive soil demineralization of the earth's soil mantle causes an eventual collapse of the global carbon cycle. The cycle is:

soil remineralization -> interglacial soil demineralization -> vegetational succession and collapse -> the glacial process -> soil remineralization

Hamaker also believes the large increase in earthquakes can be attributed to the steadily-increasing weight of snow and ice cover pressing on the molten layers just underneath the earth's crust, causing shifting and slippages. He notes that the sharp rise in major earthquakes began about 10 years after the climate began to get noticeably colder beginning in 1940. He also predicts a steadily-increasing incidence of volcanic eruptions, for the same reason, and suggests this has already begun in the last few

years.

Glaciation usually comes at a time when the earth's tectonic system has fired up volcanic activity by feeding ocean floor into the continental heaters, mostly located in the Pacific "ring of fire". Volcanic action releases larger amounts of liquified gases trapped in the molten rock. Carbon dioxide and sulfur dioxide are the main gases released, and both cause the greenhouse effect, resulting in our present "100-year cold cycle". These cycles vary in their time interval, intervals being determined by the pressure in the tectonic system. Carbon dioxide from decaying and burning mineral-starved vegetation is then added to these volcanic gases—together, they initiate the change from interglacial to glacial climate. Acidic gases from volcanism and burning forests can then stifle life on earth by leaching the few remaining basic elements into the subsoil. In this way the change from interglacial to glacial conditions can be made in 20 years (*Nature*, G. Woillard, 1979). Hamaker says that man may have moved the present glacial process! forward in time by 500 years by the continued pouring of CO2 into the air, by acidic gases and acid rain, and by forest; and jungle destruction by people seeking lumber and fuel or farmland ... the 20-year change period can also be shortened. Hamaker estimates that the beginning of a 20-year changeover period from interglacial to glacial conditions was about 1975. If this estimate is accurate, then tremendous weather changes should have begun by that time, signified by growing intensification of all storm effects, including unusually heavy rains and snows, record cold and heat, drought, hail, tornados, etc., all *symptomatic* of increasing temperature and pressure differentials, greater evaporation of moisture, and an overall speeding up of global atmospheric circulation.

Iversen warns us that in former interglacial epochs, the anthropogenic factor was negligible; i.e., *man*'s impact on nature was less dramatic than it is today.

According to Hamaker, all the requirements for glaciation are now in place and accelerating in intensity at a very fast pace: CO2 increases; precipitation pH moves toward intolerable acidity; earth's soils (demineralized) can't support a strong, healthy plant/forest cover; the carbon of the soils and trees is being transferred back to the atmosphere in huge amounts as carbon dioxide gases. As the primary infrared heat-trapping "greenhouse effect" gas, CO2 excess causes the sustained overheating of the vast oceans (especially tropical oceans), thus causing the sustained evaporation increase required to nourish the polar regions with the "food" of glaciers: water, *snow*—and keep them shaded from melting with *clouds*. This increase of glaciation is now occurring and has been since about 1950, so, although some scientists expect a warming from the greenhouse effect, the rise isn't being found over the last century—on the contrary, the earth seems to have been cooling in recent decades. The polar ice field is expanding and growing in northeast Canada (more on this in weather section), and pressure is rising in the tectonic system, indicated by the accumulation of lava flows along the ridges, and by increased volcanic activity. We're in the high-pressure part of the "ocean floor feeding cycle", which has occurred about every 100 years, at least for a few centuries.

It's certainly not a good time for CO2 to rise!

3.5 "Hope Springs Eternal"

Scientists tell us of a glacial/interglacial cycle of 100,000 years, and say we are now about 10,000 to 10,800 years into a warm interval that can last from 10,000 to 12,000 years. Some scientists also say there is a "magnetic pole reversal cycle" of 200,000 to 1,000,000 years and that, since the last one took place about 710,000 years ago, we could be "due" for one "some time in the future". As of 1984, there hasn't been much talk among the general public about Ice Ages or magnetic pole reversals; if either of these possibilities do exist, even *remotely*, as calculated by scientists, one would expect at least *some* debate on these issues to have hit the national/international media by now.

There are several explanations for the apparent lack of awareness. For one thing, countless brilliant minds go into fields totally unrelated to science, so Ice Ages and pole reversals aren't necessarily familiar to them. Then, *within* the field of science, scientists *specialize*, usually in one specific area of research, often depending on the project(s) they've received funds and grants for. They may be experts

on one particular subject, but unfamiliar with either fields of science (even related fields) or even with other areas of study within their *own* fields. They may have spent years refining a certain body of knowledge and focusing on one aspect of one branch of science. This narrows down the number of experts available on *any* given subject, let alone that of glaciation or magnetic pole reversal. Most scientists accept as fact many things they don't have the time, knowledge or money to prove for themselves, relying on research done by other scientists to fill in the gaps. This means the number of informed people who *could* "accurately" predict art onset of another Ice Age is quite limited anyway. *Within* this number of *informed* people there are: scientists *too busy* working on something else to become involved in speculation about an Ice Age; others *uninterested* one way or the other; some who have considered it, then given it no further thought; others who may have speculated on when it could come, but don't want to give their opinion because they don't want to make a mistake or prefer not to contradict scientists who think the world will warm up; others who don't want to alarm the general public (or perhaps fear causing "mass panic" or migration?); and finally, there might be a *few* who *are* willing to make a statement. As we said, this will be a rare person, one with courage of convictions, faith in his/her calculations, enough concern about humanity to bring something of such epic proportions out into the open, and nerve to contradict other scientists' theories, such as theories of scientists who initiated the Environmental Protection Agency report and the National Academy of Sciences report. Anyone who disagrees with them has to prove his own theory and discredit theirs—somewhat comparable to a single doctor challenging the entire American Medical Association—it happens, but this is probably considered an awesome task, one many professionals would undoubtedly prefer to avoid if at all possible, having their "careers" and reputations" to think about.

Scientists and experts need more than knowledge and facts—they also need intuition, the ability to synthesize what they know into an *overall picture* from all the little random bits and pieces of information. Beyond book learning, they need sensitivity and awareness, consciousness and creativity. Educated experts often lack some of these qualities needed to make good judgment and a proper diagnosis. We can see, in light of the above "analysis", that it could *indeed* be possible for the general public to miss something of such magnitude, even if it were true.

John Hamaker puts it this way: "It may seem incredible that up to now this work could have escaped becoming common knowledge, at least to workers in agriculture, forestry, geology, climatology, and other such immediately-related fields. Apparently the many diverse pieces of the glacial/ interglacial climate cycle 'puzzle' had to be gradually discovered through various disciplines over decades, before at least enough pieces were evident to be joined in a coherent picture by a trained ecological thinker."(John Hamaker in this case.) Yet now everyone may see for themselves the truth in his synthesis.

He continues: "Congress has evaluated the CO2 problem on the basis of a consensus reached by 'specialists'. They freely admit that they do not know what causes glaciation, yet say the average temperature must drop several degrees C before we can have glaciation simply because they have evidence that it does get much colder during glacial periods. They ignore the fact that, historically, glaciation has alternated with interglacial periods on a roughly 100,000-year cycle and the fact that glaciation is due. Do they think that crop soils turning to deserts (due to erosion and soil demineralization, etc.), and weather catastrophies we've observed, are all just coincidence? They haven't thought about soil and its relation to glaciation, nor the role of the tectonic system in the glacial process.

"The people charged with the responsibility for the CO2 problem are simply not trained to solve problems. They are trained to be observers and have done a creditable job of that. But the job of making a rational synthesis of the facts as a basis for Congressional action ought to have been assigned to engineers and physicists, both of whom have been trained to work with the facts and laws of Nature. The fault lies at the higher levels of education, which have neglected the necessity for interdisciplinary education and action in favor of *specialization*."

The meteorologist Harold Bernard, who also warned of CO2 increases and effects on climate, wrote a chapter "We Can't Put Weather in a Test Tube," which criticizes scientists' incorrect assumptions, inaccurate modeling techniques, and ignorance of important processes through lack of knowledge. It is

clear that the interglacial soil demineralization is one such process they have ignored. The knowledge is .now freely available.

Let's consider a parallel that Life Scientists are very familiar with by now. The concept of the body as self-healing and the body of knowledge found in the Life Science philosophy both follow the laws of common sense, of Nature, and of logic. We need only *try it* for ourselves if we want "proof", since Truth is self-evident. We have come to accept as obvious the fact that *live* food (uncooked fruit, vegetables, nuts and seeds) imparts the most perfect state of health possible. We have experienced our bodies' self-healing powers and learned about fasting as a means of allowing our bodies the chance to rest and divert all their energy into healing. We have decided that medicine and herbs interfere with the body's self-directed healing actions, and that suppression of symptoms (which are manifestations of the healing process going on) likewise interferes with the body's innate wisdom. We have found that health is produced only by healthful living and that sickness will vanish only when cause is removed (not when symptoms are suppressed). That about sums it up in a nutshell.

What I'm getting at is this: if all the above is so obvious to *us*, why isn't it obvious to the countless doctors and "health" professionals all over the world? Why is it obvious only to a *few* people? How can something be true and not be recognized by more people? All we can say is, truth is still truth, in and of itself, even if not *one* single person sees it. Truth doesn't need believers in order to be true; it doesn't need followers or majority acceptance in order to be valid. Truth doesn't have to wait for everyone to catch up. The earth was still *round* when everyone believed it was flat, despite what "everyone" thought. Microscopic life existed long before we saw it in microscopes; it didn't have to wait for us to see it in order to exist. If we are sliding into another Ice Age, and the scientists who foresee its arrival are correct, an Ice Age won't need our approval or belief in order to be a reality, that much we can be sure of.

Of course it would be easier for our own "practical purposes if some of their calculations we are "off ." After all, many so-called scientific theories *have* fallen by the wayside throughout the years, as new knowledge superceded old knowledge. Even the "world is flat" theory fell prey to the test of time. Whereas truth is truth despite what people believe, knowledge may or may not be true despite what people believe. Even if it isn't true, it may be paraded around as fact for years, centuries, or even indefinitely.

In the meantime, many people continue to believe what they're told, looking to "experts" for answers and depending on them for knowledge; it's not a foolproof learning technique, but it's often the best they can do. So, when the experts themselves make mistakes, it doesn't matter how *big* their herd of followers is—but, of course, many people *are* influenced by the size of the herd when choosing their beliefs. They feel safety in numbers, and prefer the comfort and "security" of a large herd. If "everyone else" believes something, it must be true, says their inner logic, or if nothing else, they'd *still* rather be with the majority. There *is* an alternative to joining herds and following experts: *intuition*. If you can trust your intuition, you are fortunate. As a free thinker, you can ask yourself what your intuition tells you about the world's current situation, the state of our environment, weather patterns, and Ice Ages. I've tried to present various opinions on these subjects, but I don't presume to have all the answers.

My intuition tells me to keep an open mind, and not to give up hope. If the observations and premonitions of the scientists who see the world as cooling are correct, I for one would rather have had a *hint* ahead of time than be surprised at the last minute! At least this leaves us with the option to take action, and to *try* to survive on this planet. It's been said that we don't fail until we give up trying. Hope is our strongest ally—it reinforces our will to live. Without it, we are lost, for without hope, nothing matters anymore.

So, even if an Ice Age were approaching during our lifetime, we would still have hope as our "open door". For one thing, we have the potential for *change*. Some people believe that there is a future that can be known in the present (often called destiny), but that, at the same time, there is still our free will—a powerful force that can change or alter "what is meant to be". This gives us control over our "destinies" and the ability to create the lives we choose. As we said in an earlier lesson, we *ourselves* are

responsible for our states of being; we underestimate our power as individuals when we believe that random outside influences alone shape our lives. Ironically, though, there *is also some* element of "chance "in life that can weave its influence into what we are busily creating; while we often tend to define things in simple dualities of *yes* and *no* we actually have *yes*, *maybe*, *maybe not*, and *no*. We can *predict* that something will or will not happen, and we can be very sure that it will or will not happen, if we are accurate. Even so, the fact still remains that, beyond our free will *or* any so-called destiny, there are also other powers and forces of life in the universe that can enter into every situation and coincide with any variables involved, and these sometimes alter the outcome or cause slight variations between what we expect and what actually happens. For this reason, when considering the return of an Ice Age, we can still allow for the possibility, however small, that something completely unpredictable at this present time—some unforeseeable factor—could still come to pass, something we cannot even conceive of or envision with our present knowledge or awareness. This is *not* to say that we should resort to an escapist mentality or rationalize our way out of solving our serious environmental problems by using the excuse that "a miracle could happen" as a justification for *inertia*—this would be wishful thinking and sheer delusion! We're merely trying to show that everything that happens in life is affected by the intricate interworkings of *many* multi-faceted forces, and that this includes our attempts to predict specific global climate changes. We've attempted to speculate on the past and present factors pertaining to Ice Ages, so now we're considering future factors, which, of course, also lead us to the *unknown*. Technology and scientific knowledge that we use daily and now take for granted were unimaginable to people a century ago, so it is conceivable that someone could still discover an energy force/source that is presently unknown to humanity, or find a new technique for cleaning and restoring the environment, or invent something that we can't even imagine that would change our world or its course of events. We can hope that our ingenuity *will* prove itself once more; we've gotten ourselves *into* our present world state —maybe we can get ourselves *out* of our problems, as well. There is a tremendous growth in spirit evident all over the planet—we ourselves can perform the miracle of increased awareness—with a quantum leap in consciousness, we could save ourselves by realizing what must be done before it is too late.

It has been said that our strongest instinct is to survive. When I finished reading Hamaker's book, I began to see our world ecology as a whole, and realized the importance of seeing our environmental problems collectively, as they interrelate, rather than individually. There's an old expression that comes to mind: "Couldn't see the forest for the trees." We've been looking at the trees so long that we've forgotten what the whole forest looks like. Few things can make us appreciate *life* more than the realization that it can *end*. The suggestion that time could run out for our planet forces us to reassess our values as human beings. Where are we going? What are we doing to our environment, our source of *life*? What are our real priorities? Ask anyone who's ever been told s/ he would have "only 3 months to live". The first thing that happens is a total overhaul of priorities, a total rethinking of what the person can still do. Time becomes more precious than ever before. Energy becomes focused as never before. Life is no longer taken for granted. I guess we never wake up until after we've been asleep. Let's hope we wake up in time—it seems we've ignored the alarm clock already.

Even if we are "let off the hook" somehow and an Ice Age is averted or postponed, or its timing was miscalculated to some extent, we *still* have some very important moral decisions to make regarding our ability—and, moreover, our will—to revitalize the world for our continued survival on this planet, because we are *still* left with our CO2, soil, water, and other pollution problems, and as long as we continue to put money and technological "advances" before the welfare of humanity and our ecosystem, we still have our greed to deal with. And we *still* have to figure out a way to keep from destroying ourselves in nuclear war.

One way or the other, we have to get together worldwide and face the problems that we ourselves have created. We call ourselves civilized, and we want to believe that we have advanced and evolved, but an honest appraisal of our collective self-portrait reveals that we are painting ourselves into a corner every time we compromise our ethics and assault Nature's principles. We cannot hope to survive if we destroy

our planet, because it is our source of life, but we must also understand that our survival is just as surely threatened by the destruction of our basic human values— love for humanity—and that we now have a profound need to revive and restore these basic values. Only by realizing that we *co*-exist—*what we do to others* (both psychologically *and* environmentally) we do to ourselves—can we expect to rally on the large scale necessary at this point for our survival on this planet.

It's obvious that we've been born into a time of incredible challenge, so let's meet this challenge with all our strength—and with a smile—for as always, life continues amidst the chaos. We must see the world as we *want* to be, as it must be for our survival, and use this positive image to create this world. The key to our survival lies in visualizing *and* acting for our survival over and over again until it becomes a reality. Every time another individual loses hope and gives up, our survival *as a group* is also threatened, because the force of our *collective* will to live is diminished once again. Every time our basic values of faith, hope, and charity are abandoned, the quality of life on earth is tarnished for everyone, and if we continue on a collision course with Nature, life on earth will only become more miserable. Without love, food, natural resources, and an environment clean enough to support life, people everywhere would have little to live for or to look forward to. We create our reality, and if this is the reality we choose to create, humanity as a whole will despair, and it doesn't take a genius to imagine what will happen if *no one* cares. As surely as we need faith, love, and action, we need *hope*.

Fear is the lock and laughter the key to your heart. —Stephen Stills

4. Politics Of Food Production

Since countless members of our human family are already hungry or starving, it is imperative that we find solutions *now*. Anyone who has ever grown a garden knows the disappointment of losing some plants, whether to a hungry forest animal or to an early frost, and seeing the work of *months* of tender care vanish before their eyes. A neighbor's cows got past a broken fence once and visited my garden; every corn plant was reduced to stubble and all my salad greens were lost to their hearty appetites overnight—*months* of growth were gone. Anyone who has ever planted a small fruit tree and watched its slow, steady progress, knows that it takes years before fruit will be harvested. It takes *time* to grow all food, and nothing can replace growing time when a crop is lost.

We may think we have enough food today, but we've long been pushing our luck, by pushing Nature time and time again and tampering with our environmental quality. We can no longer refuse to acknowledge and deal with our environmental and agricultural problems, and with the profound impact their *combined* effects have on our ecosystem and food supplies. We are dangerously out of touch with reality if we think we can defy the laws of Nature indefinitely with no consequences. We can't just "wait for the weather to improve", because the atmospheric carbon dioxide which is destroying temperate zone climate is increasing at an accelerating rate. Everyone who has ever studied the CO2 problem has warned that the result of permitting the rise of CO2 would be to alter the weather in ways which would be destructive to agriculture. Meanwhile, while our use of fossil fuels is increasing, our forests and jungles are fast disappearing. All this is a sure prescription for mass suicide.

What, if anything, are our world governments doing about all this? Our politicians should have begun programs for soil remineralization and biomass solar energy 15 years ago. We would now have major growing machinery and equipment industries related to food and fuel, and a better food supply with more mineral content. But what can we expect from an elective system that lets the Farm Bureau and the

corporate structure buy candidates at election time? This makes the legislature and the executive branch putty in the hands of corporate interests. The situation is the same at the federal level. Congress dispenses (out of our pockets) palliatives by the hundreds, but if we suggest solutions to problems that conflict with corporate interests, they start squeaking like mice. Ralph Nader says that 80% of the time Congress comes down on the corporate side of an issue. It really takes massive public demand to make them listen, if they listen at all.

Our ancestors came to this country to be free and independent—we are being manipulated by the power of centralized wealth, and our system of soil destruction threatens our agricultural and technical civilization. The devastation of the biosphere is seldom perceived as the ultimate threat to survival because, for many people and their governments, this issue is overshadowed by what they imagine to be more immediate concerns: war, poverty, sickness, the energy crisis, inflation, unemployment, drought, famine, and so on. What they don't realize is that the failure to conserve and rebuild living resources is closely linked to the worsening of these other problems.

Soil remineralization is a *priority* now. We were once blessed with an abundance of natural resources, but we have squandered them over the years; and we must now redirect our energy, money, and resources into positive, peaceful enterprises that will benefit all of humanity and life on this earth.

We can no longer wait for our governments to "take action"—nor can we depend blindly on systems, authority, scientists, experts, professionals,, specialists, doctors, or *someone else in general*, for our existence and survival. We cannot wait for someone else to *care* about our survival—it is *we ourselves* who have to survive. We are responsible for our own lives.

4.1 The Land of the Free, and the Home of the Brave

We, the people, *are* the government. Imagine you're a passenger in a car and the driver falls asleep just as the car is heading toward a cliff. Earlier in this lesson we mentioned some of the different types of people who make up our world. Let's listen to what *they* have to say, as the driver loses control of the car:

- Those who're unaware that problems exist: "What a fantastic view!"
- Those who remain indifferent to problems: "So what if we go over a cliff?"
- Those who trust in the system, right or wrong: "It's not the driver's fault that we're heading for a cliff—after all, his *intentions* were good."
- Those who give up hope: "Too late now—I'd better cover my eyes!"
- Those who recognize problems, but are all talk and no action: "Maybe the driver will wake up in time! Whatever happens, it's the *driver's* fault—*I'm* not to blame!"
- Those who are aware *and* take action: "I'd better grab the wheel and steer for my life!"

What would *you* do?

If our leaders, "experts", or drivers of our vehicles are asleep at the wheel, and we see the cliff coming, we're not going to have *time* to "think things over", evaluate more scientific facts, wait for the driver to wake up, or wait for a new driver. We will have to act with all the survival instinct within us, on a moment's notice.

Are we ready?

Article #1: Tropical Rain Forests: Earth's Green Belt

Left in peace, rain forests would ring the Equator with vegetation wherever days are hot and precipitation is high. But farming, ranching, logging, mining, and roads have greatly reduced their actual range.

In central Africa and Amazonia huge tracts remain largely untouched, but rain forests have been virtually eliminated from most parts of West Africa, southern Asia, and the Caribbean.

In 1980 the U.S. National Academy of Sciences estimated annual loss at 20 million hectares (50 million acres). The World Wildlife Fund speaks of 25 to 50 acres a minute. A 1982 study by two United Nations agencies reported 7.5 million hectares lost each year.

Estimates vary so widely largely because of different criteria. To biologists, loss means either conversion of primary forest—say, to agriculture, pasture, or tree plantations—or modification, implying biological impoverishment through selective logging or shifting cultivation. To foresters, loss means deforestation —the removal of all tress.

A world survey of rain forest status appears below.

South America

BRAZIL
Earth's largest rain forest little disturbed except for fringes of southern Amazonia and areas in the east. Small chance of major losses in the west for the near future.

PERU
Vast area covered by undisturbed Amazon forest. Farm settlement expected to become more extensive in next decade or two.

COLOMBIA
About one-third forested, mostly in Amazon region, some along Pacific coast. Efforts to colonize have been slowed.

VENEZUELA
Large tract in south barely touched. Smaller areas in north heavily cut, converted to ranches and farms.

GUYANA
Most of population lives along coast. Little threat to forest.

SURINAME
Virgin rain forest covers most of country, much protected by parks and reserves.

ECUADOR
Large forests along Pacific already gone, oil exploration and agriculture encroach on Ecuadorian Amazonia.

FRENCH GUIANA
Population lives along coast. Little pressure on undisturbed forest of interior.

BOLIVIA
Not much exploitation of forests yet. But government has begun roads, farming, and ranching.

Caribbean

Most island forests long ago reduced to remnants after heavy exploitation by dense populations. Small

tracts survive, for example, in the
DOMINICAN REPUBLIC, TRINIDAD AND TOBAGO, and PUERTO RICO, where a U.S. national forest protects 104 square kilometers.

MEXICO
Shifting cultivators, timber harvesters, and cattle ranchers encroach on the country's last rain forest area on the southern border with Guatemala.

Central America

A strong trend toward cattle ranching on this highly-populated isthmus has greatly reduced primary forests, now believed to be two-thirds removed. Small areas found in the Peten region of northeastern GUATEMALA, the Mosquitia Forest of eastern HONDURAS, parts of eastern NICARAGUA, southern BELIZE, the national parks of COSTA RICA. and much of PANAMA.

South Asia

INDIA
Patches of forest along the western Ghats and on Andaman lslands disrupted by landless poor, forest farmers, and logging.

BANGLADESH
Narrow belt of rain forest in Chittagong region heavily exploited by hill tribes.

SRI LANKA
Small tract on southwestern and central parts, largely disrupted by logging and slash-and-burn farmers.

Africa

ZAIRE
Holds Africa's largest rain forest (nearly one-tenth world total), parts of it now secondary growth. Some clearing by slash-and-burn farmers in south, but vast areas still undamaged by mainly rural population.

GABON
Almost entirely forested, with exploitation just beginning.

CAMEROON
Extensive disruption of large forest areas—especially in the southwest—by timber companies and slash-and-burn farmers.

CONGO
Forests in remote northern and central regions still undisturbed. Some logging in south.

IVORY COAST
More than 70 percent of primary forest at turn of century now cleared. Rest may be gone within a decade. Timber harvesting intense. Forest farming increasing rapidly.

LIBERIA
Very little primary rain forest left due to shifting cultivation.

CENTRAL AFRICAN REPUBLIC
Rainforests in south. Little pressure from small population.

NIGERIA
Most forest disrupted by dense population and a century of logging. Small areas remaining in south expected to be exploited soon.

SIERRA LEONE

Very few forest areas undisturbed by cultivators.

EQUATORIAL GUINEA
Almost totally forested. Little loss expected.

GHANA
Little or no virgin forest remains. About half removed during last 25 years by forest farmers. Remnants found in the southwest.

GUINEA
Small area still covered with rain forest in the southwest. BENIN About three-fourths of original forests left, but heavily disrupted due to strong pressure of growing population.

ANGOLA
Small rain forest concentrated in north.

MADAGASCAR
Much slash-and-burn farming. Only fragment of eastern rain forest still survives.

Southeast Asia

CHINA
Rain forests along southern coast largely disturbed, though a few areas are protected.

INDONESIA
Contains largest rain forest in Asia (nearly one-tenth world total), but much harvested already. Log production multiplied sixfold during 1960s and 1970s. Farmers and transmigrant settlers also eliminating large forest areas.

MALAYSIA
About two-thirds of lowland forests on peninsula heavily logged, converted to oil palm, rubber plantations. Large forests
on Borneo also being harvested.

PAPUA NEW GUINEA
Largely covered by undisturbed rain forest, much inaccessible to logging companies. Full-forest harvesting under way in small areas on north coast. Half of population forest farmers.

PHILIPPINES
Large timber companies harvesting remaining rain forests, less than a third of what existed 30 years ago. Clearing by rural poor also severe.

BRUNEI
Mostly covered by rain forest, much undisturbed. Revenues from oil taxes take pressure off timber cutting as source of foreign exchange.

Only pockets of forest survive in Indochina, mainly in southernmost THAILAND, lower BURMA, southern KAMPUCHEA, and parts of the Mekong Plain in VIETNAM.

Australia

Fragments of primary forest remain along east coast of Queensland. Other lowland forests heavily cut for timber, sugar plantations, mining interests, and dairy farms.

Pacific Islands

Rain forests found on southeastern side of FIJI. Major areas allocated to timber companies. About three-fourths of SOLOMON ISLANDS also forested, most in terrain too steep to harvest.